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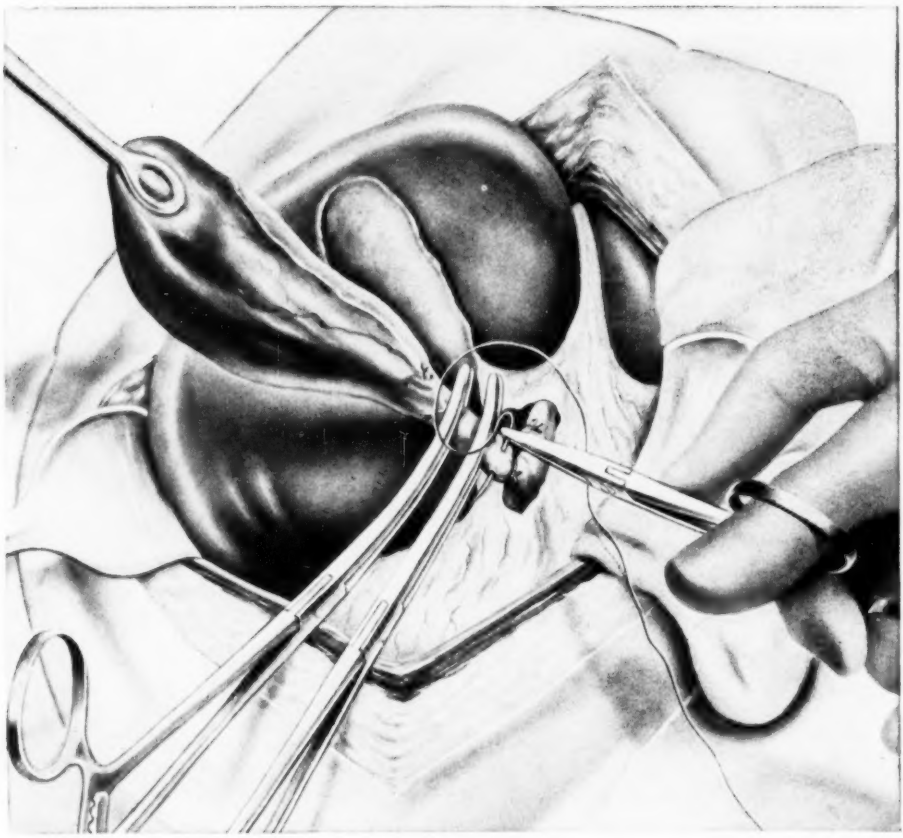

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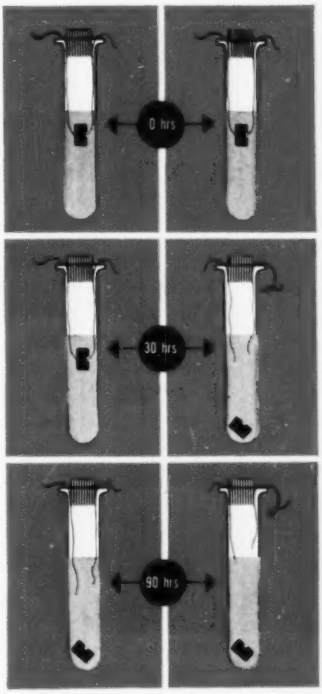


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# Editorials

## EMERGENCY UROGRAPHY

IN THE course of clinical work one encounters situations in which a differential diagnosis between renal blockage and other abdominal diseases is hurriedly requested. The urgency of the situation demands an immediate answer which will stave off or compel instant surgery. Such an emergency frequently exists in appendicitis, rupture of an abdominal viscus, rupture of a Graafian follicle, acute intercostal neuralgia, acute vasitis, acute intestinal diverticulitis, and intestinal obstruction. A similar acute situation also exists in immediate postoperative states, such as that following hysterectomy with one-sided pain; after operations upon the bladder, such as segmental resection of tumor, after excision of a diverticulum, or after surgical diathermy for bladder tumor. Whenever there is acute abdominal pain localized in either quadrant, upper or lower, the problem of correct and immediate diagnosis is imperative. The quick elimination of the kidney factor, thus revealing the actual pathology, is most important. Abdominal pains of whatever cause often simulate renal colic, making it difficult to differentiate them in an emergency. To perform a regular cystoscopy in such instances is not only undesirable but often extremely difficult and may actually be harmful. Often a general anesthetic is needed for its performance, thus adding an extra burden to any contemplated immediate surgical procedure. I have done intravenous urography in such cases without bowel preparation and have obtained enough information to be able to differentiate the pathological conditions. One does not need a regular study with complete filling of the entire upper urinary tract. All one has to know is whether or not the kidney on the affected side is blocked. Only a completely or partially blocked kidney can cause pain. Stones may be present but will not cause pain unless in a blocking position. When the pain in the upper or lower abdominal quadrants is due to upper urinary tract disease, one will frequently find a nonfunctioning kidney on the affected side. Such a finding is sufficient for diagnosis and clarifies the issue immediately, calling for relief of a blocked kidney instead of intraperitoneal surgical intervention. The reverse can also be true. A well-functioning renal tract will eliminate the kidney from further consideration and call for immediate surgical intraperitoneal exploration. By utilizing this simple study of emergency urography there will be no delay for the proper surgical intervention without dangerous procrastination.

I should like to report several instances in which emergency urography was truly a major aid in establishing the true diagnosis.

From Urological Service No. 1, The Albert Einstein Medical Center, Southern Division, Philadelphia.

*Acute Appendicitis (Atypical).*—The patient came in with right-sided abdominal pain, which subsided within one hour. It started up again and became rather severe. A stone in the ureter was suspected and cystoscopy requested. The patient was very obese and had a narrow external urinary meatus. Thiopental (pentothal®) sodium anesthesia would have to be given to dilate the urethra and pass a cystoscope. Emergency urography was done instead, revealing a normal right upper urinary tract. Immediate surgery revealed acute appendicitis.

*Left-Sided Pain Following Hysterectomy.*—In this case left-sided renal pain developed six hours postoperatively, with a rise in temperature to 101 F. Because of some pus in the catheterized urine, the possibility of acute surgical obstruction of the left ureter was suspected. Cystoscopy was suggested on the fourth postoperative day. A urogram showed excellent drainage of the left kidney without evidence of any obstruction. Cystoscopy was therefore deferred. The pain gradually subsided. The cause of the pain was never established, but it surely was not renal. This emergency urography saved the patient from an unnecessary cystoscopy.

*Suprapubic Cystotomy with Surgical Diathermy for Bladder Tumor.*—Forty-eight hours following cystotomy for bladder tumor with the application of deep surgical diathermy to the tumor on the left bladder wall, this patient experienced severe pain in the left lower abdominal quadrant with a temperature of 102 F. Acute renal block on the left side with pyelonephritis due to postoperative edema and occlusion of the left ureteral orifice was suspected. Cystoscopy with catheterization of the left kidney was suggested. Because of the poor general condition, intravenous urography was done instead and it revealed perfect drainage of the left urinary tract. The patient therefore was left alone and treated with antibiotics. The pain was probably due to peritoneal irritation on the left side from too much penetration of the current, causing localized peritonitis. The pain and local irritation subsided within 48 hours. In this case prompt urography saved the patient from a difficult and very traumatic cystoscopy 48 hours after a major bladder operation. It would probably have been a prolonged cystoscopic procedure to try to locate the ureteral orifice in an empty, collapsed bladder with a mushroom drain.

*Acute Vasitis Simulating Renal Disease.*—A man with a bad cardiac condition and severe diabetes complained of pain in the left lower quadrant for 48 hours. The temperature was 103 F. The diagnosis of left pyonephrosis was made and cystoscopy requested. On examination there was extreme tenderness in the left lower abdominal quadrant, radiating toward the left testicle. The testicle proper was slightly tender but not enlarged. Urography revealed unimpaired drainage of the left kidney. Left vasitis was diagnosed. Twenty-four hours later there appeared a notable painful enlargement of the left epididymis, revealing the true nature of the disease. Prompt urography in this case saved this cardiac patient from a cystoscopy under anesthesia.

*Technical Details.*—The actual procedure for emergency urography does not differ from the regular procedure except for the intestinal preparation and use of the compression bag. The films obtained are surprisingly good. It is best to concentrate on the affected side. Five-, 10-, and 15-minute films are sufficient to establish the activity of the kidney on the affected side.

*Conclusions.*—I recommend emergency urography in every case of questionable abdominal pain. Its performance is harmless and will reveal a great deal of information which can be obtained otherwise only by cystoscopy and ureteral catheterization, often under anesthesia.

MAURICE MUSCHAT, M.D.

# MEDITATIONS UPON THE STATUS QUO

ERWIN R. SCHMIDT, M.D.
MADISON, WIS.

IT IS with real pleasure that I address you. I am cognizant of the honor you have conferred upon me as your president, and I wish to take this opportunity to express my deepest thanks and appreciation.

The Western Surgical Association has had a long and honorable career. Its membership is drawn in large part from the West and Middle West. We elect a governor to the American College of Surgeons. We nominate a candidate to the American Board of Surgery every six years. Our membership represents a large percentage of the surgeons in certain parts of our country. Our purpose has been to present scientific programs with the most recent advances in surgery—primarily for the further education of our membership.

With the tremendous changes in the status quo, I have been deeply concerned and greatly troubled. Have we as members of the Western Surgical Association been too much occupied in our ivory towers with the science of medicine to the exclusion of a consideration of the practical aspects of meeting the medical needs of the changing times? Have we given our attention individually and collectively to the solution of problems we now meet in the status quo, or have we allowed other individuals or groups of individuals to do our thinking and planning?

It has been the tradition of medicine to stand aloof, depending upon the intangibles which have been the heritage of the profession to maintain its dignity and standing. It is my firm belief that we shall lose our birthright unless we realize that our purpose must be of a broader scope.

The time has long since come that medicine should have recognized that the great changes taking place in the world and the changes affecting the field of medicine are part and parcel of the whole. World history shows that advances are made by changes in the status quo. The factual data indicating that changes are in order are usually obvious, very obvious; yet they have to be discovered, and rediscovered, before their full impact is realized. The changes we see today involve not one aspect of life but the whole process of living. Several of the knottiest problems are facing our profession today. No doubt you, too, are greatly concerned, but who is to give the answers? Each problem involves a situation in which great wisdom is needed. What I am going to say may be called "Meditations on the Status Quo."

The medical profession has been held responsible—censured and reproached—for the increased cost of medical care. This idea has been widely and deeply implanted in the lay mind. It is used by politicians to obtain votes and enact legislation.

---

Presidential address, read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

TABLE 1.—*Hospital Expense Statement*

| | Nov., 1935 Per Diem 15,282 Pat.-Days | | Dec., 1935 Per Diem 14,998 Pat.-Days | | July-Dec., 1935-1936 Per Diem 92,084 Pat.-Days | | Fiscal Year 1934-1935 Per Diem 172,243 Pat.-Days | |
|---|---|---|---|---|---|---|---|---|
| Salaries and wages | | $1.91 | | $2.01 | | $2.00 | | $1.98 |
| Administration | $0.15 | | $0.19 | | $0.19 | | $0.19 | |
| Res. int. and teachers | 0.11 | | 0.12 | | 0.11 | | 0.10 | |
| Nursing | 1.08 | | 1.11 | | 1.11 | | 1.07 | |
| Dietary | 0.16 | | 0.16 | | 0.16 | | 0.19 | |
| Housekeeping | 0.20 | | 0.21 | | 0.21 | | 0.22 | |
| Pharmacy | 0.04 | | 0.04 | | 0.04 | | 0.04 | |
| Radiology and physical therapy | 0.04 | | 0.05 | | 0.05 | | 0.04 | |
| Laboratories | 0.10 | | 0.10 | | 0.10 | | 0.10 | |
| General | 0.03 | | 0.03 | | 0.03 | | 0.03 | |
| Food | | 0.71 | | 0.72 | | 0.66 | | 0.67 |
| General supplies | | 0.52 | | 0.55 | | 0.53 | | 0.48 |
| Dishes and silverware | 0.03 | | 0.03 | | 0.03 | | 0.03 | |
| Linen and notions | 0.04 | | 0.03 | | 0.02 | | 0.02 | |
| Cleaning | 0.03 | | 0.03 | | 0.03 | | 0.02 | |
| Blood transfusions | 0.05 | | 0.05 | | 0.06 | | 0.05 | |
| Patients' clothing | 0.01 | | 0.02 | | 0.01 | | 0.02 | |
| Braces, glasses, etc. | 0.03 | | 0.04 | | 0.04 | | 0.04 | |
| Surgical instruments and appliances | 0.08 | | 0.08 | | 0.07 | | 0.06 | |
| Gauze and bandages | 0.08 | | 0.09 | | 0.08 | | 0.08 | |
| Miscellaneous medical and surgical supplies | 0.04 | | 0.06 | | 0.05 | | 0.04 | |
| Rubber goods | 0.01 | | 0.02 | | 0.01 | | 0.02 | |
| X-ray | 0.06 | | 0.08 | | 0.09 | | 0.05 | |
| Laboratories | 0.03 | | 0.01 | | 0.02 | | 0.02 | |
| Nursing supplies | .... | | .... | | 0.01 | | 0.01 | |
| General bldg., supplies | 0.03 | | 0.01 | | 0.02 | | 0.02 | |
| Laundry | | 0.31 | | 0.30 | | 0.31 | | 0.29 |

TABLE 2.—*Hospital Operating Statement*

| Expense | Sept. 1951 Per Diem 14,653 Pt. Days |
|---|---|
| Salaries and wages | $ 8.00 |
| Legislative bonus | 2.25 |
| Retirement contribution | 0.54 |
| Office supplies | 0.05 |
| Printing and publishing | 0.05 |
| Equipment repairs | 0.13 |
| General supplies | 1.19 |
| Postage | 0.02 |
| Telephone and telegraph | 0.10 |
| Travel | .... |
| Insurance | 0.01 |
| Food | 0.90 |
| Laundry | 0.36 |
| Heat and water | 0.21 |
| Light and power | 0.86 |
| Building maintenance | 0.18 |
| Oxygen | 0.06 |
| Chemicals | 0.77 |
| Replacement of capital equipment | 0.11 |
| Dormitory amortization (resident and intern) | 0.16 |
| Photography laboratory | 0.01 |
| Shops | 0.04 |
| Cafeteria | 0.02 |
| Total expense | $15.22 |

Some factual data, such as cost accounting, in the State of Wisconsin General Hospital for a month in 1935 and another month 16 years later are interesting (Tables 1 and 2).

With reference to Table 1, other expenses not shown in December, 1935 brought the per diem rate to $4.55, of which nursing service was $1.11 (24%), food $0.72 (15%), and salaries and wages $2.01 (44%). Compare these figures with those for September, 1951: The per diem is $15.22 (234% increase), nursing service, $5.93 (434% increase); food, $0.90 (25% increase), and salaries and wages, to which have been added legislative bonus and retirement contributions, $10.79 (436% increase).

In 1935, nursing was 24%, food 15%, and salaries and wages 44% of the total per diem. In 1951, nursing was 38%, food almost 6%, and salaries and wages 70% of the total per diem. In 16 years the increase of the total per diem was 234%, nursing service 434%, food 25%, and salaries and wages 436%.

This simple analysis would seem to show that the medical profession is not responsible for the increased medical cost, and to blame it is fallacious, unjust, and unfair. This same comparison may be applied to the overhead involved in private practice.

Great changes have taken place in the training of the medical profession. The sum total of medical knowledge has increased greatly. We, who attempt to teach the young men and women going into the profession, are often reminded of the parson in Oliver Goldsmith's "Deserted Village":

> And still they gaz'd and still the wonder grew
> That one small head could carry all he knew.

During the course of years the general background of the physician has been enlarged by the requiring of three or four years of undergraduate work. The medical course, with the increase of medical knowledge, has remained at four years. Some schools require a year of internship before the degree is granted. Much planning and thought are needed. Is there no cultural value in medical subjects? William J. Parish, in the *Phi Kappa Phi Journal* of May, 1951, in discussing "Higher Education, An Economic Service in the Preservation of Democracy," says: "What is the responsibility of higher education in the preservation of democracy? The answer is, the creation of work habits through the challenges and disciplines of intellectual problems in broad and liberal fields of learning."

Eight or nine years must be spent to complete the preliminary work and the internship. Add three to five years to this for residency training, and the total is eleven to fourteen years. A doctor of philosophy, the highest academic degree a university can confer upon a person, requires a minimum of seven years.' Is it necessary for the physician to spend so much time in preparation? Should the time allotted to undergraduate school, medical school, internship, and residency be revised?

Some special problems in the intern year concern themselves with whether there is a free choice of selection, rather than a distribution of internships on the basis of the need of the hospitals; whether the selection is made on the basis of the training a candidate may obtain in the course of a year; whether the salaries paid are a criterion of the excellence of the training, or whether there is an exploitation taking place with the assent of the medical profession.

Is the function of the specialty boards to certify that these licentiates are teachers, research men, or safe men to practice their specialty? Must they be limited 100% to their specialties? How far should specialty boards go? Shall we go to the extreme of the Egyptians, having a special board for "the cutting of a stone"? De Quervain noted this tendency when he decried the encroachment of the surgical specialties in the field of general surgery. The specialty boards which have been set up have done a great service in the training of specialists and the raising of standards. We must remember, too, that most of the surgery is still done by the general man.

In our house, all is not well. The relationship between the medical man and the radiologist, pathologist, laboratory man, anesthetist, and hospital administrator is in a state of flux. This makes the medical profession vulnerable. It makes for confusion; no united front can be presented, and this lends aid to the bureaucrats.

The nursing profession is following in the footsteps of the medical profession. It is not necessary to have a college degree followed by a nursing degree. For those who wish to be teachers, supervisors, or heads of schools of nursing there have always been special schools and courses. It is not necessary for all training schools to have the faculty and facilities of a university school of nursing. Because many schools of nursing can no longer meet the requirements of the state boards, they have had to discontinue their activities. The supply of nurses has many additional demands made upon it by social service, governmental services, industry, and the practice of medicine. The more highly trained the nurse is, the more likely she is to wander away from nursing and enter some ancillary field. The makeshift substitute is the training of attendants. There has been poor direction and lack of vision.

A definite trend, which is an insidious entering wedge in the carrying out of projects and programs, is subsidization. Expediency has battered down principles, tradition, and independence. This means the centralization of power and direction is in the hands of a few. It is very general, but we have reached this stage easily and almost without knowing it.

I have enumerated only a few of the many vital problems which are facing us today because of the complexity of society, the mounting national and international tensions, and progressive changes. Would it not seem that, in the solution of many of these difficulties, our profession is best qualified to be of service?

This Association, with the remainder of the medical profession, must strengthen those aspects of our program that are concerned with these vital issues, and they must be met with great wisdom and discernment of judgment. We must be leaders; we must have a pervasive influence; we must, more than ever before, have courage and integrity and not stray from the path of duty, faith, and ideals; we must consecrate and dedicate ourselves anew to our great work that our noble profession may be used for the bringing of a better day for all.

1937 Arlington Place.

# ACUTE INTESTINAL OBSTRUCTION IN INFANCY

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OMAHA

INTEREST in the urgent abdominal procedures of infancy has greatly increased in the past 20 years. This report deals with 53 consecutive infants having acute intestinal obstruction and presents some observations on their management.

Included in this series are five different groups of conditions producing or resulting in acute intestinal obstruction (Table 1). These are are in order of frequency intussusception, duodenal obstruction, small bowel obstruction from multiple causes, incarcerated or irreducible inguinal hernia, and imperforate anus. Pyloric obstruction, whether due to a hypertrophic pyloric muscle or to the more infrequent causes, has been excluded from this discussion.

## DUODENAL OBSTRUCTION

Twelve cases of duodenal obstruction were observed that necessitated 13 operative procedures (Table 2). The primary symptom was vomiting since birth, intermittent in type and usually projectile in character. In the majority of instances the vomitus contained bile. Peristaltic waves were visible across the upper abdomen in 10 of the 12 cases. Routine x-ray examination disclosed a dilated stomach and in some patients a markedly distended duodenum, with little or no gas in the remaining bowel (Fig. 1).

The average age at the time of surgery was 11 days, with a range of from 2 to 30 days. The average known period of symptoms was eight days.

Three of these obstructions were due to congenital bands or adhesions about the duodenum; five were associated with malrotation of the colon, and four resulted from various causes, including two cases of duodenal atresia, one of nonspecific acute duodenitis, and one circular pancreas.

Treatment entailed severance of congenital bands and adhesions in seven cases, gastrojejunostomy in four, and duodenojejunostomy in one. The over-all mortality was two deaths, or 16.7%, occurring in infants 5 days and 21 days of age.

## SMALL BOWEL OBSTRUCTION

Eleven cases of small bowel obstruction were seen, in which 13 operative procedures were done (Table 3).

Vomiting and abdominal distention, accompanied by a varying degree of fever and dehydration, depending upon the duration of the obstruction, were the principle

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TABLE 1.—*Intestinal Obstruction in Infancy*

| Cause of Obstruction | Number of Cases | Average Age | Duration of Symptoms | Mortality, % |
|---|---|---|---|---|
| Duodenal obstruction | 12 | 11 days | 8.5 days | 16.7 |
| Small bowel obstruction | 11 | 7.5 wk. | 12 days | 64.0 |
| Intussusception | 19 | 14 mo. | 36 hr. | 15.7 |
| Incarcerated inguinal hernia | 7 | 13 mo. | 11 hr. | 0.0 |
| Imperforate anus | 4 | 24 hr. | 24 hr. | 25.0 |
| | 53 | | | 24.5 |

TABLE 2.—*Obstruction of Duodenum in Infancy*

| | |
|---|---|
| Total number of cases | 12 |
| Average age (days) | 11 |
| Average duration of symptoms (days) | 8 |
| Pathology | |
| 1. Duodenal bands | 3 |
| 2. Malrotation colon with duodenal bands | 5 |
| 3. Other causes | 4 |
| Treatment | |
| 1. Lysis of band | 7 |
| 2. Gastrojejunostomy | 4 |
| 3. Duodenojejunostomy | 1 |
| Results | |
| Recovered | 10 |
| Died | 2 |
| Mortality (%) | 16.7 |

TABLE 3.—*Obstruction of Small Bowel in Infancy*

| | |
|---|---|
| Total number of cases | 11 |
| Average age (months) | 4.5 |
| Average duration of symptoms (days) | 9.5 |
| Pathology | |
| 1. Inflammatory | 2 |
| 2. Congenital | 6 |
| 3. Mechanical | 3 |
| Treatment | |
| 1. Decompression | 4 |
| 2. Exploration—lysis of adhesions | 3 |
| 3. Short circuit | 4 |
| Results | |
| Recovered | 4 |
| Died | 7 |
| Mortality (%) | 64 |

Fig. 1.—Congenital duodenal obstruction in infancy. There is a dilated stomach with very little gas in the small bowel.

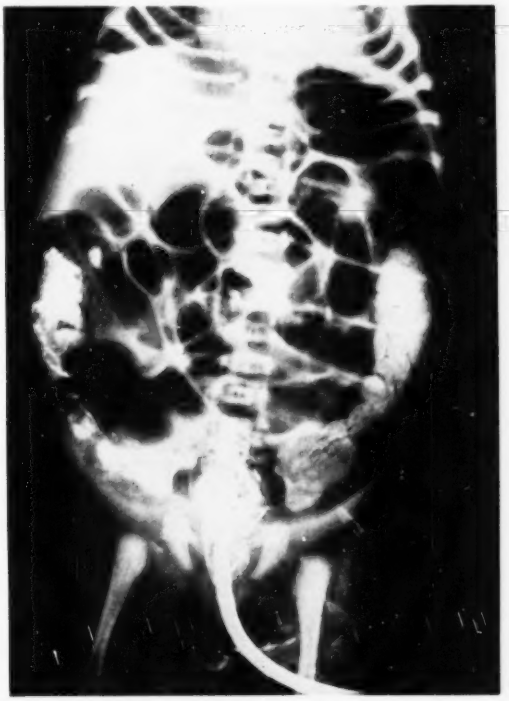

Fig. 2.—Advanced small bowel obstruction in infant, with markedly dilated small bowel, free peritoneal fluid, and patent colon.

symptoms in this group. X-ray examination revealed small bowel distention with fluid levels in all instances.

The average age at the time of surgery was 7½ weeks, with a range of from 3 days to 8 months. The average duration of symptoms at the time of operation was 12.2 days.

In 6 of the 11 cases the obstruction was congenital in origin, in 3 it was mechanical, and in 2 it was on an inflammatory basis. Specifically the obstructions resulted from congenital adhesions, volvulus, meconium ileus, and atresia (Fig. 2).

Surgical decompression was undertaken in four cases, exploration with lysis of bands in three, and a short-circuiting procedure in four.

This group of cases were the most discouraging in the series, with 4 recoveries and 7 deaths, resulting in a mortality of 64%.

TABLE 4.—*Intussusception in Infancy*

| | |
|---|---|
| Total number of cases | 19 |
| Average age (months) | 13 |
| Average duration of symptoms (hours) | |
| Series | 36 |
| Cases with resection | 64 |
| Pathology | |
| 1. Ileocolic | 17 |
| 2. Ileal | 1 |
| 3. Colic | 1 |
| Treatment | |
| 1. Reduction | 12 |
| 2. Resection | 7 |
| Results | |
| Recovered | 16 |
| Died | 3 |
| Mortality (%) | 15.7 |

## INTUSSUSCEPTION

Nineteen cases of intussusception were observed in which the average age of the patients was 13 months on admission (Table 4).

The average duration of symptoms for the series was 36 hours, but it is very significant that the illness averaged 64 hours in those cases in which resection was required.

In 17 cases the intussusception was ileocolic in type, in 1 instance ileal, and in 1 entirely colic. Barium enemas were routinely used preoperatively for confirmation of diagnosis and for partial reduction of the classic ileocolic type. In no instance, however, was the barium enema alone used as a therapeutic measure (Fig. 3).

Surgical management entailed reduction in 12 cases and resection in 7. There were three deaths in the entire group, giving a mortality of 15.7%. Two of the deaths followed resection, one from shock and one from a postoperative pulmonary complication. The third death resulted from a gangrenous ileum on the fifth postoperative day, apparently due to vascular thrombosis after simple reduction.

This group of cases confirms the prognostic significance of the duration of symptoms, and our experience has also impressed us with the importance of the preoperative temperature. In the late cases with obvious distention and temperature of 102 F. or higher after hydration resection has generally been required, and they have evidenced the usual stormy postoperative course with marked febrile reactions. In such cases, we believe, however, that the decision to proceed with resection should be made promptly, without undue trauma from extensive manipulation. Arbitrarily

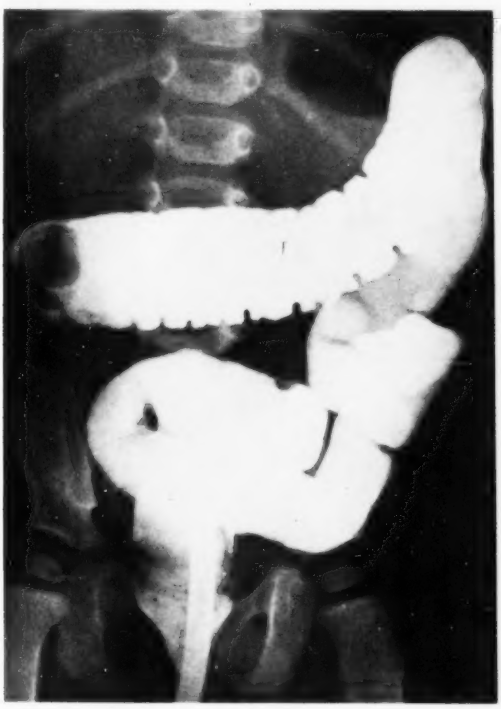

Fig. 3.—Ileocolic intussusception, with intussusceptum clearly visible at hepatic flexure.

it is our feeling that if one cannot accomplish the reduction in 10 minutes' time, utilizing the various accepted methods, it is better to proceed immediately with resection.

### INCARCERATED INGUINAL HERNIA

Seven cases of incarcerated inguinal hernia requiring emergency reduction and repair were observed (Table 5). The average age at the time of operation was 13.2 months, with a range of from 3 weeks to 3 years. The average duration of symptoms at the time of operation was 11 hours.

The characteristic symptom was that of a painful, irreducible swelling in the groin of an extremely fretful infant. In only one instance were vomiting and abdominal distention noted, since this is one type of lesion that is usually seen early in its course.

Surgical reduction with a high sac ligation and limited repair was carried out in these seven infants without mortality. In no instance was resection necessary.

TABLE 5.—*Irreducible Inguinal Herniae in Infancy*

| | |
|---|---|
| Total number of cases | 7 |
| Average age (months) | 13 |
| Average duration of symptoms (hours) | 11 |
| Pathology | |
| 1. Incarcerated | 5 |
| 2. Reduced with anesthesia | 2 |
| 3. Strangulated | 0 |
| Treatment | |
| 1. Reduction and repair | 5 |
| 2. Repair and appendectomy | 2 |
| Results | |
| Recovered | 7 |
| Died | 0 |
| Mortality | 0 |

TABLE 6.—*Imperforate Anus in Infancy*

| | |
|---|---|
| Total number of cases | 4 |
| Average age (hours) | 26 |
| Average duration of symptoms (hours) | 24 |
| Pathology | |
| 1. Defect less than 2.5 cm. | 2 |
| 2. Loop blind above peritoneum | 2 |
| Treatment | |
| 1. Perineal repair | 2 |
| 2. Perineal exploration—colostomy | 2 |
| Results | |
| Recovered | 3 |
| Died | 1 |
| Mortality (%) | 25 |

### IMPERFORATE ANUS

Four infants with imperforate anus were observed, their average age being 26 hours on admission (Table 6). X-ray examination of the infants in the inverted position was carried out in each instance and was found helpful in estimating the length of the defect.

Three of the four infants had definite abdominal distention at the time of operation, and in this condition a moderate degree of colonic distention is very helpful in bulging the lower rectal segment into the perineum.

In two instances the perineal defect was less than 2.5 cm., and perineal continuity of the bowel was reestablished. In the other two, the rectal pouch ended blindly above the pelvic peritoneum, necessitating abdominal exploration and colostomy (Fig. 4).

There was one death, a mortality of 25%. This infant had, in addition to its imperforate anus, multiple congenital defects of its urogenital system.

Fig. 4.—Infant with imperforate anus photographed in inverted position to demonstrate length of existing defect.

## COMMENT

The diagnosis and treatment of intestinal obstruction in infancy offers a real challenge in mechanics and physiology for those interested in the care of children. The history is usually very limited, and the working information must be obtained by examination and through competent x-ray assistance.

There are certain principles in the surgical management of these obstructions that must be followed. These must form a ritual which is constant for every case if a lowered mortality is to be obtained.

A short period devoted to hydration is essential, and this can usually be accomplished in three or four hours' time. Decompression of the small bowel by suction is rarely feasible for these infants prior to operation. Gastric lavage is essential to assure an empty stomach during anesthesia and to facilitate exploration.

Exploration should never be undertaken without introduction of a cannula or plastic tube into a suitable vein so that blood may be administered immediately. This cannula may be left in place and used for the immediate postoperative administration of fluids. Adequate anesthesia, usually with open drop ether, is employed, and an experienced anesthetist can vary the depth as the requirements of the procedure demand.

The incisions employed must be ample for adequate exploration without undue trauma through retraction. In malrotation, volvulus, and suspected atresia, it is usually expedient and necessary to deliver the entire small bowel and a portion of the colon to permit orientation and prompt repair.

Enterostomy and exteriorizing procedures should be avoided if possible in surgery on infants. Reestablishment of intestinal continuity is most desirable to reduce fluid loss and permit early feeding.

In the surgery of infants, time is an important factor, and gentleness with the rapid performance of a procedure will carry many seemingly hopeless problems through a major operative episode.

## DISCUSSION

DR. EDWIN M. MILLER, Chicago: This problem of acute intestinal obstruction is with us always and may apply to an infant one day old or an adult 90 years old. Dr. McLaughlin has certainly covered the essential points well.

I believe that it is not so necessary to stress the treatment of acute obstruction in infants before such a group as the members of the Western Surgical Association as it would be to emphasize the importance of these problems in the presence of general practitioners, obstetricians, and pediatricians, because ordinarily they are the ones who see these infants first, and therefore they are the ones who should keenly realize the necessity for having these little patients come to the surgeon early enough to permit something of value to be accomplished. I have had a fairly extensive experience in this field during the past 25 years and have successfully operated upon 7 out of 11 infants a few days old with atresia of the duodenum, to say nothing of others with varying degrees of stenosis; but for infants with obstructions lower in the small intestine, especially when an atresia has been present and involved the lower ileum, our results, like those in other clinics, have not been very good, and I think our failures may properly be attributed to the fact that most of these infants have come to surgery too late—usually at the stage when some degree of necrosis of the enormously distended proximal bowel has already taken place and some degree of local peritonitis is already present.

In surgical treatment I would particularly emphasize the importance of thorough deflation of the distended proximal bowel before the lateral anastomosis has begun and also the value of the use of a very minute catheter above the anastomosis to take the tension off the suture line for the following few days.

In conclusion, I should say that when all is said the problem really boils down to a question of early enough diagnosis.

# APPENDICITIS DURING FIRST TWO YEARS OF LIFE

## Report on Twenty-One Cases and Review of Four Hundred Forty-Seven Cases from the Literature

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AND
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LOS ANGELES

APPENDICITIS in the age group from birth to 2 years is of special interest for the following reasons: (1) It is not the most frequent cause of an acute condition in the abdomen as it is in older children and adults; (2) it has been reported 447 times in the literature; (3) it masquerades as gastrointestinal upsets and upper respiratory infections until 71% of the cases have perforated, and (4) there is now available a program of management that, despite late diagnosis, will almost achieve Charles McBurney's cherished goal of saving "all of them."

Attention was focused on appendicitis in infancy by Griffith [1] at the turn of the century, and again in 1917 by Abt,[2] who at that time found but 80 reported cases. At present (1951) 367 additional cases have been reviewed in the literature [3]

From the Department of Surgery, University of Southern California Medical School, and the Childrens Hospital.

Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

1. Griffith, J. P. C.: Univ. Pennsylvania Bull. **8**:300, 1901.

2. Abt, I.: Arch. Pediat. **34**:641, 1917.

3. (*a*) Bolling, R. W.: Acute Appendicitis in Children, J. A. M. A. **83**:963 (Sept. 27) 1924. (*b*) Christopher, F.: Appendicitis in Children Under 5 Years of Age, Am. J. Dis. Child. **31**:525 (April) 1926. (*c*) Farr, C. E., and Brakeley, E.: S. Clin. North America **8**:1193, 1928. (*d*) Stone, C. S., Jr.: Acute Appendicitis in Children, Arch. Surg. **30**:346 (Feb.) 1935. (*e*) Heyl, J. H.: New York J. Med. **36**:332, 1936. (*f*) Potts, W. J.: Acute Appendicitis in Children, Am. J. Dis. Child. **55**:511 (March) 1938. (*g*) Caldwell, E.: Surg., Gynec., & Obst. **67**:169, 1938. (*h*) Edberg, E.: Acta paediat. **26**:121, 1939. (*i*) Hudson, H. W., and Chamberlain, J. W.: J. Pediat. **15**:408, 1939. (*j*) Alford, K. M.: Arch. Dis. Childhood **16**:43, 1941. (*k*) Penberthy, G. C.; Benson, C. D., and Weller, C. N.: Ann. Surg. **115**:945, 1942. (*l*) Anderson, S. G.: M. J. Australia **2**:567, 1944. (*m*) Scott, H. W., Jr., and Ware, P. F.: Acute Appendicitis in Childhood, Arch. Surg. **50**:258 (May) 1945. (*n*) Williams, H.: Brit. M. J. **2**:730, 1947. (*o*) Greene, J. J.: Am. J. Surg. **77**:744, 1949. (*p*) McLanahan, S.: Ann. Surg. **131**:853, 1950. (*q*) Abel, W. G., III, and Allen, P. D.: Ann. Surg. **132**:1093, 1950. (*r*) Morton, T. V., Jr., and Kilby, R. A.: Am. J. Surg. **80**:576, 1950. (*s*) Porter, L.: California J. Med. **16**:10, 1918. (*t*) Farr, C. E.: Arch. Pediat. **36**:207, 1919. (*u*) Schwartz, A. B., and Leebron, J. D.: Arch. Pediat. **41**:280, 1924. (*v*) Heekes, J. W.: Brit. M. J. **1**:571, 1924. (*w*) Beekman, F.: Ann. Surg. **79**:538, 1924. (*x*) Hill, W. B., and Mason, C. C.: Prenatal Appendicitis with Rupture and Death, Am. J. Dis. Child. **29**:86 (Jan.) 1925. (*y*) Root, A. S.: Arch. Pediat. **44**:483, 1927. (*z*) Pope, S.: Brit. M. J. **2**:307, 1927. (*a'*) Ham, C. I.: Ibid. **1**:1006, 1927. (*b'*) Somers, R. H.: Northwest Med. **27**:344, 1928. (*c'*) Corcoran, W. J.: Prenatal Rupture of Appendix, Am. J. Dis. Child. **39**:277 (Feb.) 1930. (*d'*) Swartzwelder, W. R.:

*(Footnote continued on next page)*

(Tables 1, 2, and 3). The information thus accumulated is supplemented by a study of the records of 21 additional cases (Table 4) made available by the staff of the Los Angeles Childrens Hospital. The present-day management of a sick, toxic infant with general peritonitis from appendicitis is discussed.

## INCIDENCE

Acute appendicitis occurring during the first two years of life is truly rare. Among approximately 25,000 hospitalized patients in this age group there were 21 proved cases, that is, a hospital incidence of 0.1%. Intussusception, Meckel's diverticulum, and malrotation are much commoner in this age group.

TABLE 1.—*Collected Series of Cases of Appendicitis in Childhood, Showing Incidence in First Two Years*

| Source | Year | Total No. of Patients in Series | No. of Patients Aged | |
|---|---|---|---|---|
| | | | 0-1 Yr. | 1-2 Yr. |
| Bolling [2a] | 1924 | 123 | 0 | 8 |
| Christopher [4b] | 1926 | 44 | 1 | 2 |
| Farr [3c] | 1928 | 889 | 0 | 9 |
| Stone [3d] | 1935 | 258 | 0 | 6 |
| Potts [3e] | 1938 | 502 | 3 | 15 |
| Caldwell [3f] | 1938 | 220 | 0 | 12 |
| Edberg [3g] | 1939 | 1,638 | 0 | 8 |
| Hudson [3h] | 1939 | 848 | 2 | 22 |
| Alford [3i] | 1941 | 170 | .. | 16 |
| Penberthy [3k] | 1942 | 1,653 | 18 | 38 |
| Anderson [3l] | 1944 | 943 | .. | 17 |
| Scott [3m] | 1945 | 500 | 1 | 22 |
| Williams [3n] | 1947 | 1,487 | 1 | 11 |
| Greene [3o] | 1949 | 194 | .. | 9 |
| McLanahan [3p] | 1950 | 823 | .. | 4 |
| Abel and Allen [3q] | 1950 | 1,165 | 2 | 22 |
| Morton [3r] | 1950 | 100 | .. | 2 |
| Childrens Hospital | 1951 | 1,051 | 5 | 16 |
| Totals | | 12,794 | 34 | 247 |

Arch. Pediat. **47**:263, 1930. (*e'*) Langston, H. J.: Virginia M. Month. **57**:446, 1930. (*f'*) Lipshutz, B.: Arch. Pediat. **48**:649, 1931. (*g'*) Kempton, R. M.: J. Michigan M. Soc. **31**:188, 1932. (*h'*) Swartz, D.: Canad. M. A. J. **27**:58, 1932. (*i'*) Kirschenmann, J. J.: Am. J. Surg. **16**:318, 1932. (*j'*) Martin, W. F.: South. Med. & Surg. **94**:518, 1932. (*k'*) Greenthal, R. M. Arch. Pediat. **52**:639, 1935. (*l'*) Rosamond, E.: J. Arkansas M. Soc. **32**:35, 1935. (*m'*) Simon, M. M.: Am. Med. **41**:93, 1935. (*n'*) Krock, F.; Billingsley, C. B., and Weddington, R. E.: J. Arkansas M. Soc. **32**:161, 1936. (*o'*) John, R. W.: Lancet **2**:1097, 1936. (*p'*) Coleman, F. H.: Ibid. **1**:1008, 1936. (*q'*) Ch'eng, Y. H., and K'ang, H. J.: Chinese M. J. **52**:876, 1937. (*r'*) McCarthy, P. A., and Magrath, J.: Pennsylvania M. J. **41**:5, 1937. (*s'*) Miller, G. I.: M. Rec. **146**:121, 1937. (*t'*) Campbell, D. D.: Brit. M. J. **1**:1102, 1938. (*u'*) Deaver, J. M., and Martin, A. G.: Surg., Gynec. & Obst. **66**:962, 1938. (*v'*) Burger, T. O., and Torbert, H. C.: Am. J. Surg. **42**:429, 1938. (*w'*) Tittle, G. A.: Texas J. Med. **34**:684, 1939. (*x'*) O'Neill, T.: Brit. M. J. **2**:87, 1941. (*y'*) Black, B. M., and Waugh, J. M.: Proc. Staff Meet., Mayo Clin. **17**: 328, 1942. (*z'*) Emerson, A. H.: Am. J. Surg. **59**:563, 1943. (*a''*) Etherington-Wilson, W.: Proc. Roy. Soc. Med. **38**:186, 1945. (*b''*) Kellert, E., and Kumouchel, A.: Arch. Pediat. **65**:194, 1948. (*c''*) Kelley, T. H.: Illinois M. J. **43**:454, 1923. (*d''*) Howland, J.: Medical Aspects of Acute Appendicitis in Children, J. A. M. A. **83**:961 (Sept. 27) 1924. (*e''*) Flusser, E.: München. med. Wchnschr. **80**:609, 1933. (*f''*) Basch, F.: Soc. argen. de cir. **6**:201, 1945. (*g''*) Caballero, A.: Soc. argen. de cir. **6**:218, 1945. (*h''*) Kirminsson and Guimbellot, quoted by Basch, F.[60]

TABLE 2.—*Single Case Reports of Appendicitis in Patients Under 2 Years of Age in the Literature from 1917-1950*

| Source | Year | Sex | Age | Symptoms and Diagnosis | Appendectomy | Drainage | None | Pathology of Appendix | Recovered | Died |
|---|---|---|---|---|---|---|---|---|---|---|
| Porter [28] | 1918 | .. | 18 mo. | 4 days vomiting, abdominal pain | .. | .. | .. | Gangrenous | + | .. |
| Farr [31] | 1919 | M | 20 mo. | 3 days vomiting, abdominal pain | + | .. | .. | Perforated | + | .. |
| Schwartz [30] | 1924 | M | 6 mo. | 3 days ? intussusception | + | .. | .. | Acute | + | .. |
| Heekes [29] | 1924 | M | 4 mo. | Signs of intussusception | + | .. | .. | Acute | + | .. |
| Beekman [28] | 1924 | M | 20 mo. | "Sick 3 days" | + | .. | .. | Acute | .. | + |
| Hill [28] | 1925 | F | Newborn | 2 days abdominal distention | + | .. | .. | Perforated | .. | + |
| Root [29] | 1927 | F | 16 mo. | Repeated attacks abdominal pain | + | .. | .. | Abscessed | + | .. |
| | | .. | 8 mo. | 3 days vomiting, temperature 103 F | + | .. | .. | Acute | + | .. |
| | | M | 13 mo. | 7 days diarrhea, 1 day vomiting | .. | + | .. | Perforated | .. | + |
| Pope [33] | 1927 | M | 3 wk. | Scrotal abscess, sinus tract | + | .. | .. | Perforated | + | .. |
| Ham [34'] | 1927 | M | 12 days | 1 day strangulated inguinal hernia | + | .. | .. | Gangrenous | + | .. |
| Somers [35'] | 1928 | .. | 3 mo. | 12 hr. signs intussusception | + | .. | .. | Acute | .. | + |
| Corcoran [36'] | 1930 | M | 48 hr. | Convulsions; retracted abdomen | .. | .. | + | Perforated | .. | + |
| Swartzwebler [37] | 1930 | F | 24 mo. | Vomiting, abdominal pain, temperature 101 F | + | .. | .. | Perforated; peritonitis | .. | + |
| Langston [38'] | 1930 | M | 5 wk. | Strangulated inguinal hernia | + | .. | .. | Acute | + | .. |
| Lipshutz [39'] | 1931 | M | 9 mo. | 12 hr. vomiting, temperature 103 F | + | .. | .. | Gangrenous | + | .. |
| | | M | 17 mo. | 24 hr. vomiting, temperature 103 F | + | .. | .. | Perforated | + | .. |
| Kempton [40'] | 1932 | M | 18 mo. | 9 days vomiting, watery stools | .. | .. | + | Perforated | .. | + |
| Swartz [25'] | 1932 | F | 23 mo. | 2 days abdominal pain, vomiting | + | .. | .. | Perforated | + | .. |
| Kirschenmann [41'] | 1932 | M | 24 mo. | 4 days U. R. I., 3 days abdominal pain | + | .. | .. | Perforated | + | .. |
| Martin [42'] | 1932 | M | 15 mo. | 3 days signs intussusception | + | .. | .. | Perforated | .. | + |
| Greenthal [43'] | 1935 | M | 6 mo. | 4 days U. R. I., ? intussusception | + | .. | .. | Gangrenous | + | .. |
| Rosamond [44'] | 1935 | .. | 10 mo. | 20 hr. vomiting, abdominal rigidity | + | .. | .. | Acute | + | .. |
| Simon [20'] | 1935 | F | 16 mo. | 48 hr. anorexia, abdominal pain | + | .. | .. | Acute | + | .. |
| Krock [45'] | 1936 | M | 3 wk. | 2 wk. vomiting, peritonitis | .. | + | .. | Perforated, peritonitis | .. | + |
| John [26'] | 1936 | F | 16 days | (premature) 4 days vomiting | .. | .. | + | Perforated | .. | + |
| Coleman [27'] | 1936 | F | 5 mo. | 9 hr. abdominal pain, ? intussusception | + | .. | .. | Acute | + | .. |
| Ch'eng [24'] | 1937 | M | 3 days | 9 days symptoms intestinal obstruction | .. | .. | + | Gangrenous, peritonitis | .. | + |
| McCarthy [22'] | 1937 | F | 8 mo. | 3 days vomiting, diarrhea | + | .. | .. | Perforated | + | .. |
| Miller [23'] | 1937 | M | 2 days | Congenital umbilical hernia | + | .. | .. | ..... | + | .. |
| Campbell [21'] | 1938 | M | 2 mo. | 24 hr. pain, inguinal hernia | + | .. | .. | Perforated | + | .. |
| Deaver [24'] | 1938 | .. | 20 mo. | 36 hr. vomiting, distention | + | .. | .. | Perforated | + | .. |
| Burger [47'] | 1938 | M | 6 wk. | 3 days strangulated inguinal hernia | + | .. | .. | Gangrenous | .. | + |
| Tittle [48'] | 1939 | M | 16 mo. | 4 days symptoms | + | .. | .. | Gangrenous | .. | + |
| O'Neill [32'] | 1941 | M | 5 wk. | 8 hr. strangulated inguinal hernia | + | .. | .. | Gangrenous | + | .. |
| Black [49'] | 1942 | M | 14 days | Incarcerated hernia | + | .. | .. | Acute | + | .. |
| Emerson [50'] | 1943 | F | 3 mo. | 24 hr. fever, anorexia | + | .. | .. | Perforated | + | .. |
| Etherington-Wilson [51''] | 1945 | M | 14 days | 2 days vomiting, abdominal pain | .. | + | .. | Perforated | .. | + |
| Kellert [52''] | 1948 | M | 12 mo. | 12 hr. vomiting, abdominal pain | + | .. | .. | Perforated | + | .. |
| Total | | | | 39 cases—14 deaths, or 36% mortality | | | | | | |

The occurrence of acute appendicitis during the first year of life is about one-seventh as frequent as during the second year (Fig. 1). This fact has been established from the reported series (Table 1) that have accumulated since Abt's time. In contrast to this, he found an equal number in each of the two age groups, as his

TABLE 3.—*Miscellaneous Reports of Appendicitis in Patients Under 2 Years of Age*

| Source * | Year | No. of Patients Aged | |
|---|---|---|---|
| | | 0-1 Yr. | 1-2 Yr. |
| Kelley [35] | 1923 | 1 | 4 |
| Howland [34] | 1924 | .. | 7 |
| Flusser [32] | 1933 | .. | 6 |
| Basch [37] | 1945 | 4 | 8 |
| Basch [37] | 1945 | 5 | .. |
| Caballero [33] | 1945 | 2 | 5 |
| Kirminsson [36] | 1945 | 9 | 17 |
| Totals | | 21 | 47 |

* None of these authors gave the total number from which these cases were selected.

TABLE 4.—*Analysis of 21 Cases of Appendicitis in Patients Under 2 Years of Age*

| Case No. | Age, Mo. | Symptoms * | Temperature | WBC | Preparation | | | Appendectomy | Recovery |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Antibiotics | Fluids | Time | | |
| 1 | 1 | 3-day irritability | 102 | 38,000 | No | 120 S ? | ..... | No | No † |
| 2 | 1 | 9-hr. incarcerated hernia | 100 | 11,000 | No | No | 1 hr. | Yes | Yes |
| 3 | 4 | Diarrhea since birth | 102 | 18,000 | No | ? S | 2 hr. | Yes | No † |
| 4 | 5 | 5-day vomiting | 103 | 25,000 | No | No | 24 hr. | Yes | No † |
| 5 | 9 | 1-week diarrhea | 101 | 19,000 | No | No | 16 hr. | Yes | Yes |
| 6 | 14 | 16-day diarrhea | 101 | 14,000 | No | Oral | ..... | No | Yes |
| 7 | 14 | 3-day vomiting | 102 | 14,000 | No | No | 5 hr. | Yes | Yes |
| 8 | 16 | 2-day vomiting | 103 | 25,000 | No | Oral | 10 hr. | Yes | Yes |
| 9 | 17 | 1-day vomiting | 102 | 6,000 | No | 250 S | 9 hr. | Yes | Yes |
| 10 | 17 | 1-month limp | 101 | 15,000 | No | Oral | 72 hr. | Drainage | Yes |
| 11 | 19 | 30-hr. abdominal pain | 103 | 23,000 | No | No | 2 hr. | Yes | Yes |
| 12 | 19 | 5-day vomiting | 101 | 23,000 | No | Oral | 7 days | Drainage | Yes |
| 13 | 19 | 10-day fever | 101 | 16,000 | No | Oral | 18 hr. | Drainage | Yes |
| 14 | 19 | 2-day irritability | 102 | 19,000 | No | No | 1 hr. | Yes | Yes |
| 15 | 19 | 4-day vomiting | 103 | 21,000 | Yes | 500 S | 18 hr. | Yes | Yes |
| 16 | 20 | 1-week diarrhea | 102 | 15,000 | No | 600 S | ..... | No | No † |
| 17 | 21 | 3-day vomiting | 102 | 11,000 | No | No | 1 hr. | Yes | Yes |
| 18 | 21 | 2-day vomiting | 102 | 21,000 | Yes | 1200 S | 18 hr. | Yes | Yes |
| 19 | 22 | 24-hr. abdominal pain | 101 | 22,000 | Yes | No | 2 mo. | Yes | Yes |
| 20 | 24 | 10-hr. vomiting | 102 | 20,000 | No | No | 1 hr. | Yes | Yes |
| 21 | 24 | 1-week anorexia | 99 | 16,000 | No | Oral | 18 hr. | Yes | Yes |

* Duration of symptoms over 3 days: 67%.
† See analysis of deaths, under Results.

data were collected from single case reports and not from large series. The series reports reflect a truer incidence of appendicitis in infants than do single case reports, since the latter represent a selected group.

The incidence of acute appendicitis by three-month intervals during the first two years of life, as recorded in single case reports from all the literature but not from large series, is as indicated in Figure 2, derived from Table 2 combined with

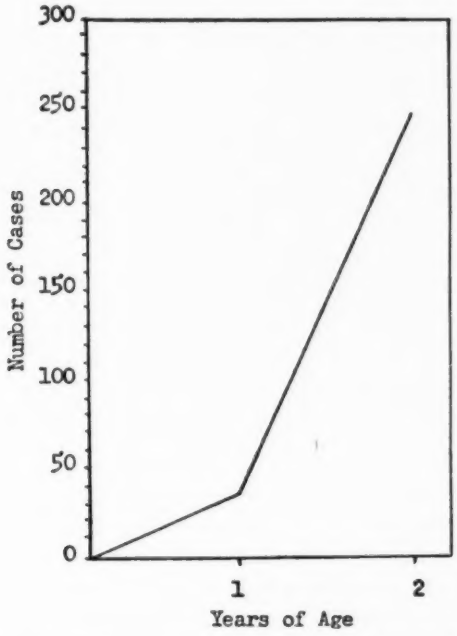


Fig. 1.—Age incidence of appendicitis in first 2 years of life, as tabulated from 18 series and shown in Table 1.

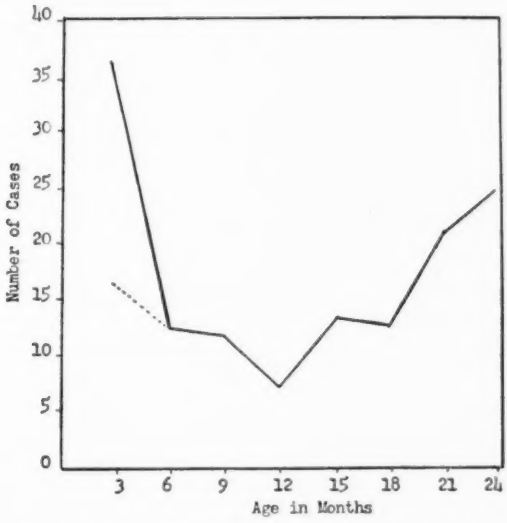


Fig. 2.—Age incidence of appendicitis at three-month intervals from all single case reports in the literature. Dotted line indicates revised incidence when cases of appendicitis caused by extraneous conditions, such as strangulated hernia, are excluded.

Abt's report. According to the tabulation, the higher incidence in the first 3 months is due, in part, to the inclusion of 19 cases caused by strangulated hernia and other extraneous conditions.

### ETIOLOGY

Treves,[4] in 1885, classified the anatomy of the cecum and appendix into common types. Figure 3 is a modified sketch of his original drawings. In our study of the cecum and appendix in 20 consecutive stillborn infants, all were of the fetal type. In a report by Wangensteen and others,[5] 15 of the twenty specimens examined during the first year of life were of the fetal type, whereas in the following years the frequency of the persistence of the immature form steadily decreased. Thus, presupposing obstruction as the basic cause of appendicitis and recognizing that the fetal type of cecum with its dependent, funnel-shaped appendix is less likely to become obstructed, then it is easy to understand the increasing incidence of appendicitis as the cecum matures throughout childhood (Fig. 4). Changes in diet, the upright position, and frequent respiratory and intestinal infections, have also been mentioned as etiological agents.

### MANIFESTATIONS AND DIAGNOSIS

"The symptoms of appendicitis in infants show such marked variation from those which occur in older children and adults that the presence of the disease in very young children is worthy of special attention" (Abt[2]).

Much of the variation, unfortunately, is of a negative character. Pain and tenderness are very difficult to interpret and often impossible to localize. Vomiting is so frequent in infancy that during the first day or two it does not suggest appendicitis. These obstacles have been insurmountable for even such masters as Abt[2] and Brennemann.[6]

The positive points diagnosis, however, consist of persistent vomiting, continued inability to nurse or take nourishment, prolonged fretfulness, crying or sleeplessness, the presence of constipation or diarrhea, and/or some elevation in temperature. Examination of many infants may often reveal abdominal tenderness or spasm or distention. The presence of any of these positive findings, whether properly localized or not, is the keystone to early diagnosis. An elevated temperature and white blood cell count are frequent but not essential (Table 4, Case 9). Rectal examination can be of help. Urinary findings do not rule out appendicitis, as many have found to their regret. The combination of respiratory disease or enteritis with appendicitis in infancy has been reported sufficiently often to make this pitfall worthy of emphasis. The differential diagnosis of primary peritonitis (Alford,[3] Ladd and Gross[7]) has been stressed, but when any doubt exists its management is the same as for peritonitis.

4. Treves, F.: Brit. M. J. **1**:473, 1885.

5. Wangensteen, O. H.; Buirge, R. E.; Dennis, C., and Ritchie, R. P.: Ann. Surg. **106**:910, 1937.

6. Brennemann, J.: Abdominal Pain of Throat Infections, Am. J. Dis. Child. **22**:493 (Nov.) 1921.

7. Ladd, W. E., and Gross, R. E.: Abdominal Surgery of Infancy and Childhood, Philadelphia, W. B. Saunders Company, 1941, pp. 200-229.

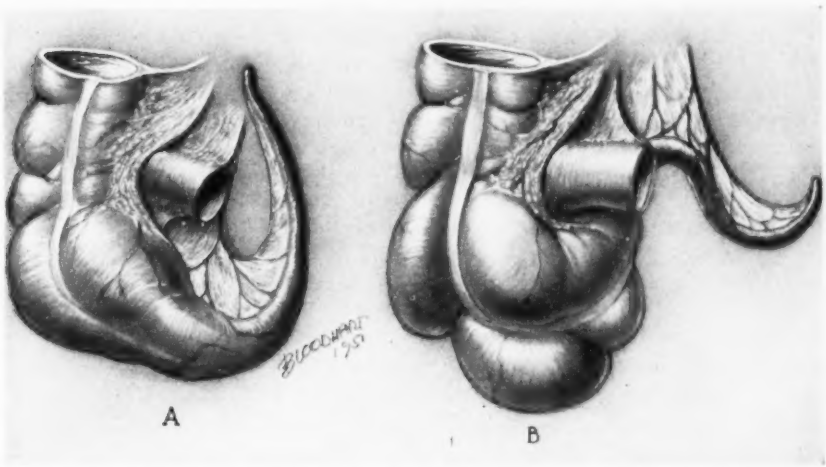


Fig. 3.—*A*, showing fetal-type cecum and appendix with funnel-shaped opening into cecum. *B*, showing adult form with narrowed connection into cecum.

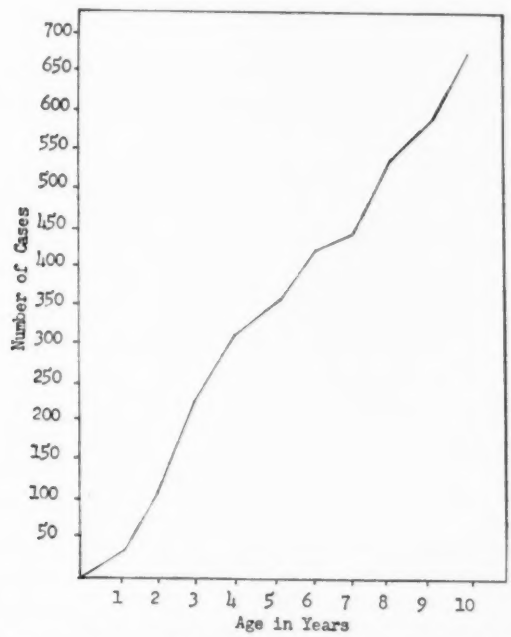


Fig. 4.—Incidence of appendicitis throughout childhood, as recorded by Penberthy, G. C.; Benson, C. D., and Weller, C. N.: Ann. Surg. **115**:945, 1942; Potts, W. J.: Acute Appendicitis in Children, Am. J. Dis. Child. **55**:511 (March) 1938; Caldwell,[38] Ladd and Gross,[7] and Childrens Hospital (3,713 cases).

DURATION OF SYMPTOMS

In the infants in the Childrens Hospital series, symptoms had existed three days or longer in 67% of the cases before the diagnosis was made (Table 4), whereas in the statistics on appendicitis in patients of all ages (Green [8]), only 20% had symptoms of this duration. This delay in diagnosis for infants has been thus far insurmountable, probably accounting for the high incidence of perforation and

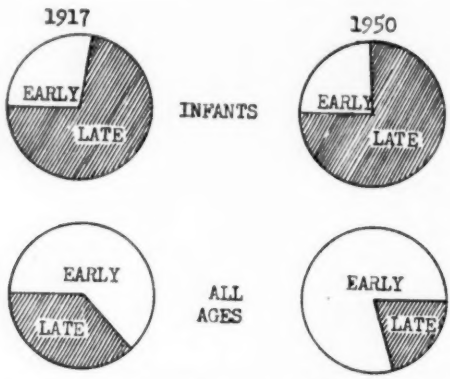


Fig. 5.—Proportion of early and late diagnoses of appendicitis. Left upper circle calculated from Abt's [2] 1917 report in which in 73% of cases there was perforation or abscess formation. Right upper circle represents present collected series from the literature as recorded in Table 5. Left lower circle represents statistics from Beekman's review (Beekman, F.; Smith, M. K., and Everingham, S.: Am. J. M. Sc. **154**:490, 1917) in which in 63% of the cases diagnosis was made before the 3rd day. Right lower circle portrays Green's findings [8] in which 80% of patients came to surgery before the third day of the attack.

TABLE 5.—*Perforation with Peritonitis or Abscess in Infants Under 2 Years of Age*

| Source | Year | No. Patients Under 2 Years | No. with Perforation or Abscess | % |
|---|---|---|---|---|
| Bolling [33] | 1924 | 8 | 7 | 87 |
| Flusser [36] | 1933 | 6 | 5 | 83 |
| Potts [37] | 1938 | 18 | 14 | 77 |
| Hudson [31] | 1939 | 24 | 22 | 92 |
| Scott [30] | 1945 | 23 | 22 | 95 |
| Baseh [34] | 1945 | 5 | 4 | 80 |
| Caballero [35] | 1945 | 7 | 1 | 14 |
| McLanahan [9] | 1950 | 4 | 3 | 75 |
| Morton [38] | 1950 | 2 | 0 | 0 |
| Single Case Reports (Table II) | | 39 | 22 | 56 |
| Childrens Hospital, 1950 (Table IV) | | 21 | 11 | 52 |
| Totals | | 157 | 111 | 71 |

general peritonitis, rather than a suspected rapid course.[9] The insuperable difficulties in making an early diagnosis for infants is graphically represented in Figure 5.

PERFORATION WITH PERITONITIS OR ABSCESS

When all reported cases are combined (Table 5) the incidence of perforation, peritonitis, or abscess in infancy is 71%. It is significant that when Abt [2] sur-

8. Green, H. W., and Watkins, R. M.: Surg., Gynec. & Obst. **83**:613, 1946.

9. Martin,[9f] Ladd.[7]

veyed the literature in 1917 he found a 73% incidence of advanced disease. Thus, up to the present time, the urging of early diagnosis and surgery has not been effective in diminishing the incidence of peritonitis. Its treatment, however, is a different story and now can be almost 100% successful.

### MANAGEMENT OF PERITONITIS

No final word has been written on the management of peritonitis, but the statistical reduction of the death rate from this cause, as recorded by Chandler, Long, and Ott,[10] is strong evidence that present-day methods of management are exceedingly successful. Each case is an individual problem, but the following measures are generally applicable: (1) gastric and upper intestinal suction; (2) intravenous administration of fluids and electrolytes; (3) full dosages of antibiotics; (4) postponement of surgery in the case of a sick, toxic child until improvement is evident, and (5) removal of the offending organ. In addition, analgesics, blood transfusions, oxygen, and vitamins are frequently of importance.

Specifically, in a 12-month-old, 20 lb. (9 kg.) sick, toxic child, with the tentative diagnosis of ruptured appendicitis and general peritonitis, a No. 12 catheter is inserted into the stomach and constant aspiration applied. The tube can be kept open with "caroid" (a proprietary proteolytic enzyme obtained from the fruit of the papaya) solution irrigations (1 gm. of "caroid" in 100 cc. of tap water, 10 cc. for each irrigation). A polyethylene tube is inserted into the ankle vein and a constant drip of 5% dextrose in 0.45% saline solution at 20 drops per minute is started. In three hours, this will deliver about 250 cc. of fluid. Administration of additional fluids is then estimated on the basis of the urinary output and blood studies. Blood chemistry values—chlorides, carbon-dioxide-combining power, sodium, potassium, and nonprotein nitrogen—are determined. The blood is matched and 200 cc. made available for those patients who need it. If the potassium is low or if the clinical history is one of severe depletion, a potassium-containing fluid is added. The child is given intravenous injections of aureomycin, 50 mg. of hydrochloride in 100 cc. of fluid twice daily and 50,000 units of penicillin every three hours.

### ACTIVE PREPARATION OVER A PERIOD OF HOURS

The actual time required for preparation, of course, is a variable matter and depends on the general condition of the patient at entry. The depleted, toxic child, even more than the adult, is in a precarious position if surgery is performed hastily without adequate preparation. Returning the acid-base and fluid balance to normal requires time. This fact has been experimentally demonstrated by Darrow,[11] the interval being dependent upon the length and severity of the depletion. The equilibrium between the altered cations and anions and the replenishment of water lost cannot be restored en route to the operating room or without adequate administration of fluids intravenously. Most authors (McLanahan,[3p] Scott,[3m] and Abel and Allen [3q]) have stressed this point in recent years, and it is one of the salient factors reducing the mortality now, as compared with that of the days of immediate emergency surgery. In Abel and Allen's most recent review, the average time

10. Chandler, C. A.; Long, P. H., and Ott, E.: Ann. West. Med. & Surg. **3**:266, 1949.

11. Darrow, O. C.; Schwartz, R.; Ianucci, J. E., and Courville, F.: J. Clin. Invest. **27**:198, 1948

required for preparation in 260 children was nine hours. After the preparation has been started, x-rays and other special studies can be obtained. Usually within 4 to 8 hours, improvement in general appearance and pulse rate is manifest and surgery is performed, but this may be delayed even up to 18 hours. In recent cases, the patient's urinary output has been measured and surgery delayed until at least 100 cc. has been excreted. Even in those cases in which peritonitis from other causes, primary peritonitis, intussusception, torsion, etc., is suspected, adequate time for preparation is still essential.

### SURGERY IN ALL CASES

Over the years, the pendulum has swung from delayed to immediate surgery and back again to a modified delayed surgery, accompanied by active supportive measures. The only real controversial issue regarding surgery in appendicitis revolves around those cases in which an abdominal mass has formed in the region of the appendix with walling-off. The present trend for children, however (McLanahan,[3p] Norris and Brayton,[12] and Abel and Allen [3o]), is for operation in every case. Although conservative therapy has been advocated recently for these patients, none of the reports (Schulz [13]) shows such a low mortality as McLanahan's,[3p] who in general favors early surgery for all patients.

### ADVANCES IN TECHNIC

Especially for these very young patients, the preoperative diagnosis may be none too certain. The surgeon must therefore be prepared to resect an intussusception, to deal with Meckel's diverticulitis, malrotation of the intestine, or any other acute abdominal condition that may be present.

When the diagnosis is clear, a McBurney incision has an increasing number of advocates, but the right rectus incision is still perhaps the best approach for most infants.

The fear with which surgeons in the past have approached the opening of an intraperitoneal abscess is still present, but today, with local suction and antibiotics, simple drainage of an appendiceal abscess can usually be replaced by removal of the appendix, except when the general condition of the patient prohibits this.

Gentle use of the gloved finger is perhaps the best method of dissection. Small incisions have no place in the removal of an inaccessible or retrocecally placed appendix. Intraperitoneal drainage is reserved for the true abscess, but drainage down to the peritoneum is used routinely when the wound is contaminated.

### POSTOPERATIVE CARE

The postoperative care is the continuation of the preoperative therapy. Suction is continued until peristalsis is audible. Administration of antibiotics is continued until the reaction has subsided for several days. Oral administration of aureomycin or terramycin is substituted for the intravenous injection as soon as possible. The daily requirement of sodium, potassium, dextrose, protein, and water must be calculated accurately on the basis of loss, basic requirement, and blood levels. Approxi-

12. Norris, W. J., and Brayton, D.: California Med. **68**:162, 1948.

13. Schulz, I.: Perforated Appendix in Children, Arch. Surg. **56**:117 (Jan.) 1948.

mately 50 cc. per pound (0.5 kg.) of body weight of total fluids is required, in addition to the loss by suction. Transfusions are given at about 10 cc. per pound of body weight when indicated.

## RESULTS

For infants under 2 years of age the mortality as reported in the literature (Table 6) was 29%. In the present series of 21 cases (Table 4) it was 19%. A detailed analysis of this smaller series reveals the fact that each of the four deaths was due to a ruptured appendix and general peritonitis; none of the four patients had received the present preoperative measures outlined in this paper. All deaths occurred before antibiotics were being used, and none of the patients received such treatment during the preoperative period. Two patients were not operated on. Of

TABLE 6.—*Mortality in Infants Under Two Years of Age*

| Source | No. of Cases | Deaths | Mortality % |
|---|---|---|---|
| Bolling [34] | 8 | 3 | 37 |
| Howland [34''] | 7 | 1 | 14 |
| Farr [3c] | 9 | 2 | 22 |
| Flusser [3e''] | 6 | 2 | 33 |
| Heyl [3e] | 9 | 3 | 33 |
| Caldwell [3g] | 12 | 5 | 25 |
| Edberg [3h] | 8 | 2 | 25 |
| Hudson [3i] | 24 | 4 | 16 |
| Penberthy [3k] | 56 | 15 | 28 |
| Anderson [3l] | 17 | 8 | 47 |
| Scott [3m] | 23 | 3 | 13 |
| Basch [3f''] | 17 | 3 | 18 |
| Caballero [3e''] | 7 | 1 | 14 |
| Kirminsson [3b''] | 26 | 14 | 54 |
| Williams [3n] | 12 | 3 | 25 |
| Greene [3o] | 9 | 4 | 44 |
| McLanahan [3p] | 4 | 0 | 0 |
| Abel and Allen [3q] | 24 | 10 | 41 |
| Morton [3r] | 2 | 0 | 0 |
| Single Case Reports, Table 1 | 39 | 14 | 36 |
| Childrens Hospital | 21 | 4 | 19 |
| Totals | 340 | 101 | 29 |

the two operative deaths, one patient did not receive fluids preoperatively and the other had but two hours of preparation.

## SUMMARY

Appendicitis is not the commonest cause of an acute abdominal emergency in infants under 2 years of age. Intussusception, Meckel's diverticulum, malrotation, etc., far exceed it. There have been reported 447 cases in the literature.

The fetal type of cecum persists in the very young, and, since this type is less likely to become obstructed, this fact may explain the low incidence of appendicitis in this group.

One-seventh as many cases of appendicitis occur in the first year of life as in the second. In 67% of the cases in the series here reported diagnosis of appendicitis was not made until after three days or later. In 71% of all cases reported in the literature, perforation, peritonitis, or abscess had developed by the time the diagnosis was made. The over-all mortality in the literature was 29% and in this series 19%.

Many hours must be spent in preparing the sick, toxic infant with suction, fluids, blood, and antibiotics before surgery is indicated. Removal of the appendix is indicated when the infant has been prepared.

## CONCLUSIONS

From a study of the literature and of the 21 cases at the Los Angeles Childrens Hospital, we are convinced that despite delays in diagnosis, ruptured appendicitis with general peritonitis in infants under 2 years of age can be successfully treated by appendectomy if the patients are prepared by replacing of lost fluids and electrolytes, applying gastric suction, and administering antibiotics, blood, and oxygen, and provided these measures are continued for one or more four-hour periods or until there is clinical improvement and at least 100 cc. of urine has been secreted. The exact amounts of fluids to be administered vary with the individual case. In an average four-hour period, intravenous injections of 15 cc. of 0.45% saline solution in 5% dextrose, 5 cc. of blood, and 5 mg. of terramycin is given for each pound of body weight. No additional salt is supplied unless the loss through vomiting or diarrhea has exceeded the amount given. Dextrose in water is the substitute for the saline solution. Potassium is added as indicated.

# ACUTE APPENDICITIS IN INFANTS

## Fifteen-Year Study

CLIFFORD D. BENSON, M.D.
JOHN J. COURY Jr., M.D.
AND
DONALD R. HAGGE, M.D.
DETROIT

THE MEDICAL profession is well aware of the frequency and seriousness of appendicitis and its complications in children. However, this awareness is not shared by all the profession or the laity regarding this disease as it affects infants aged 24 months or younger. There is a good reason for this, as appendicitis is not of frequent occurrence in the infant. The clinical picture of acute appendicitis in the child is of a fairly fixed pattern, but in the infant the opposite may be true. The clinical picture may assume a variable pattern of symptoms and signs which make it difficult for the parent and physician to suspect or recognize the disease before peritonitis has developed.

We realize that the physician and pediatrician literally see hundreds of infants with fever and vomiting and mild abdominal pain not due to appendicitis; therefore it becomes a difficult problem to distinguish the infant whose symptoms represent those of appendicitis. Constant vigilance and suspicion will enable the physician to recognize the illness as appendicitis.

In a review of a group of infants with appendicitis it is generally found that the large majority are admitted with a complicating peritonitis. This is due to the following facts: (1) all too liberal use of cathartics by well-meaning parents for an "upset stomach," (2) inability of the infant to express or localize his complaints, (3) inability of an underdeveloped omentum to assume its protective role, and (4) the retention by the cecum of a high position, tending to obscure the true nature of the disease.

### CLINICAL MATERIAL

In this 15-year review of our patients at the Children's Hospital of Michigan and in our private service at Harper Hospital, 39 infants have been treated for acute appendicitis and its complications during the years 1936 to 1951. All the diagnoses in this series were confirmed by microscopic evidence of acute disease, or if the appendix were not removed the clinical picture was such that a positive diagnosis was established beyond any reasonable doubt.

### INCIDENCE

*Age.*—As has been previously established, all the patients in this series were 24 months of age or younger. It will be noticed that of the 39 patients appendicitis occurred in only 3 patients under 12 months of age, whereas the remaining 36 patients were between 12 and 24 months. The youngest infant operated upon was

From the Surgical Services of the Children's Hospital of Michigan and Harper Hospital.
Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

7 weeks of age, and this infant recovered. We see a relative gradual increase of appendicitis during the second year of life, with the greatest incidence during the 21st and 22d months of life.

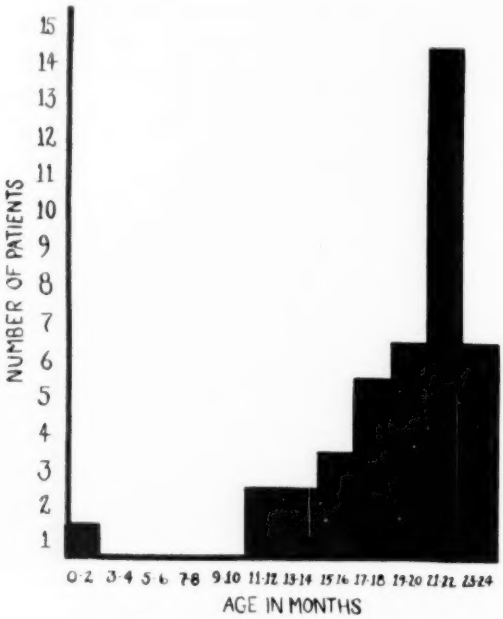


Chart 1.—Age incidence of appendicitis.

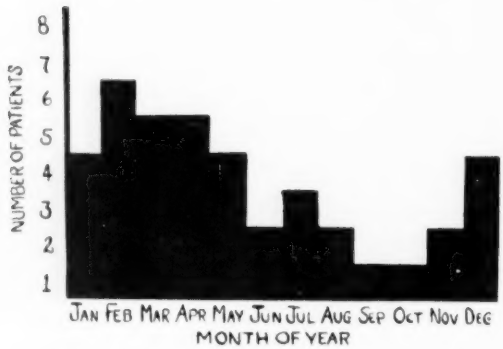


Chart 2.—Seasonal incidence of appendicitis in infants.

*Sex.*—Males showed the usual predominance; 69% of our patients were male, and 30.8% were female.

*Race.*—There were 35 white and 4 Negro infants. This emphasizes the greater incidence of appendicitis in the white infant, since the total number of patients treated on our surgical wards are about equally distributed between the two races.

*Seasonal.*—Although many attempts have been made to establish some correlation between seasonal and monthly incidence of appendicitis, such attempts have never been too conclusive. However, from our series we find that 28 cases, or 71.7%, did occur in the winter and spring months. This perhaps indicates an increased frequency of the disease in this select age group when upper respiratory diseases are at their height. This was also borne out to a certain extent by Abel and Allen [1] in their study of appendicitis in children.

## SYMPTOMS AND DIAGNOSIS

Many years ago Dr. Julius Hess made the statement that one of the most difficult diagnosis in pediatrics was that of appendicitis in the infant. This is still true because of the variability of the clinical course of appendicitis in the infant. It has been well stated by McLanahan [2] that "any discussion of the diagnosis of appendicitis should start with the axiomatic principle that abdominal pain, vomiting and slight

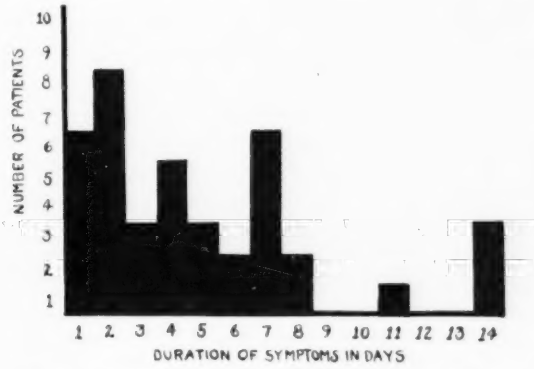


Chart 3.—Duration of symptoms of appendicitis in infants.

fever should always be considered due to appendicitis until proved otherwise." The triad of symptoms that was presented most frequently in this series was that of abdominal pain, vomiting, and fever. In the child and adult the classic picture of abdominal pain, followed by nausea and vomiting and local tenderness, is a fairly consistent syndrome. This sequence of events probably prevails in the infant, but in most instances it is more difficult to evaluate. Vomiting and fever often preceded the onset of abdominal discomfort. Abdominal pain may have ushered in the symptoms of appendicitis, but the parent was in many instances unable to recognize it as pain until the infant became irritable, and the thighs were flexed on the abdomen as a protective measure. One of the most reliable points in the history is that of abdominal pain or discomfort persisting over 8 to 12 hours without apparent relief. In our review seven of the infants who had appendiceal peritonitis had an associated

1. Abel, W. G., III, and Allen, P. D.: Acute Appendicitis in Children, Ann. Surg. **132**:1093, 1950.

2. McLanahan, S.: Further Reductions in the Mortality in Acute Appendicitis in Children, Ann. Surg. **131**:853, 1950.

diarrhea, further confusing the clinical picture. We have been impressed by the need for repeated examinations at short intervals in order to make a diagnosis. Also, if we are unable to secure a satisfactory abdominal examination in an infant we do not hesitate to sedate the patient with a small dose of barbiturate per rectum. This in instances has allowed us to make a better evaluation of the abdominal signs.

Furthermore, it is to be emphasized that in any infant suspected of having acute appendicitis and in whom the abdominal findings are not definite it is highly important to do a rectal examination to elicit local tenderness or the presence of a pelvic mass.

The duration of symptomatology prior to hospitalization has varied a great deal in our series. One infant was admitted 6 hours following the onset of symptoms, but the converse was also true in that we find that three infants were admitted after a 14-day illness.

The average rectal temperature in the infants with acute nonperforated appendicitis was 100.9 F. The lowest temperature in this group was 99.6 F., and the highest was 102.4 F. The average rectal temperature in the infant with acute perforated appendicitis was 102.8 F., with the lowest being 99.2 F. and the highest being 105 F.

It is well known that too much reliance cannot be placed on the leucocyte count in making a diagnosis of appendicitis or in determining the severity of appendicitis and its complications. It is of inestimable value when taken into consideration with the entire clinical picture. In this series the average leucocyte count of infants with acute appendicitis was 12,286, the lowest being 7,300 and the highest being 18,200. The average leucocyte count of infants with appendicitis with perforation and peritonitis was 17,584, the lowest being 5,700 and the highest being 38,600.

It is interesting to note that those infants who were admitted with a rectal temperature of 104 F. or higher and whose disease was of longer duration than the others in this series did not have a leucocyte count above 14,500. The lowest leucocyte count in this series was 5,700. This patient was admitted to the hospital on the eighth day of his illness with a rectal temperature of 105 F. This again illustrates that an elevated leucocyte count is of value but that a low leucocyte count does not rule out appendicitis or its complications when the clinical picture is fairly evident.

### CORRELATION OF PATHOLOGY AND TREATMENT

In the following tabulation we have correlated the pathological findings and treatment.

| | |
|---|---|
| Appendicitis, acute | 7 |
| Treatment | |
| Operative—appendectomy | 7 |
| Appendicitis, perforated, with peritonitis | 13 |
| Treatment | |
| Operative | 9 |
| Appendectomy | 1 |
| Appendectomy with intraperitoneal drainage | 6 |
| Intraperitoneal drainage | 1 |
| Intraperitoneal drainage with interval appendectomy | 1 |
| Conservative | 4 |

| | |
|---|---|
| Appendicitis, perforated with mass | 19 |
| Treatment | |
| Operative | 14 |
| Appendectomy | 1 |
| Appendectomy with intraperitoneal drainage | 5 |
| Intraperitoneal drainage only | 3 |
| Intraperitoneal drainage with interval appendectomy | 5 |
| Conservative | |
| Returned for interval appendectomy | (2) |

As shown in the preceding tabulation, there are three major classifications: (1) acute appendicitis, which comprised 17.9% of the series of patients, (2) appendicitis, perforated with peritonitis, which comprised 33.3%, and (3) appendicitis, perforated with mass, which comprised 48.7% of the total number of patients.

It is universally accepted that once the diagnosis of acute appendicitis has been established immediate appendectomy is indicated.

Infants who are seen with clinical evidence of perforated appendix with peritonitis, with nonlocalization or mass, it is now generally agreed, should be operated upon as soon as they can be adequately prepared for surgery. This preparation must be a matter of individualizing the treatment to the patient. The measures instituted are the correction of dehydration and ketosis with proper intravenous fluid therapy, nasogastric suction for decompression, and chemotherapy being instituted immediately to prepare the sick infant better for surgical intervention. A number of hours may be necessary for this preparation. As to the operative procedure in this group of patients, we believe that appendectomy with thorough aspiration of the abdominal fluid is highly essential. The tendency toward less frequent use of intraperitoneal drainage has been in evidence during the past five years in our experience, not only in infants but in children. There has been a lessened tendency toward mechanical small bowel obstruction of inflammatory origin, but there has been an increase in the number of residual pelvic infections in the immediate postoperative period. These have not been of any great significance, as they have resolved under chemotherapeutic measures.

The real controversy as to therapy exists in the group of patients who present themselves with the signs of appendiceal perforation and a mass in the right lower quadrant or pelvis. After the conclusion is reached that a localized mass is present, there are two courses open to the surgeon—namely, surgical intervention with or without appendectomy and a conservative nonoperative plan. It is well known that in the infant the mass may be formed by agglutination of small bowel loops or cecum to the parietal peritoneum, and the appendiceal abscess may be small. Furthermore, the omentum is underdeveloped in the infant and does not offer the protection to the infant that it does to the child or adult. It has been our policy to evaluate individually each patient entering the hospital with a mass in the right lower quadrant or pelvis. If the temperature and pulse and mass show a gradual decrease in 24 to 72 hours under fluid replacement, nasogastric suction, and chemotherapy, we continue to treat the patient expectantly. In our series 19 patients were admitted with perforated appendices and a mass in the right lower quadrant or in the pelvis. Five patients were treated conservatively, with one death. The remaining 14 patients had surgical procedures performed as follows: One had appendectomy with no intraperitoneal drainage; 5 had appendectomy and intraperitoneal drainage; 8 had surgical drainage of a "walled-off" appendiceal abscess. Of the latter group five returned for interval appendectomy, and in the group treated conservatively four

recovered under this management, but only two returned for interval appendectomy. We find this a distinct hazard in the management of this type of patient, as there is always the possibility that there may be a recurrence of appendicitis until the appendix is removed. Our routine has always been to advise interval appendectomy 10 to 12 weeks following the discharge of the patient from the hospital if the conservative plan has been used, but we have learned from this study that parents do not always abide by this advice. Nevertheless, intraperitoneal drainage alone is justified in the seriously ill infant with a "walled-off" abscess and when not only an added appendectomy would be technically difficult but the prolongation of the operative procedure would seriously endanger the life of the infant.

In this group as well as others we are again impressed with the necessity of adequate preoperative preparation if surgery is to be carried out. In the postoperative course of all these patients we appreciate the rational use of the antibiotic agents, nasogastric suction, and intravenous fluid therapy.

### ANALYSIS OF DEATHS

In the following tabulation we have summarized the therapeutic course of our 39 patients in the 15 year period 1936 to 1951. It will be noted that all the deaths occurred in the first five year period, 1936-1941.

| Procedure | Five-Year Period | | | Total |
|---|---|---|---|---|
| | 1936-1941 | 1941-1946 | 1946-1951 | |
| Appendectomy | 0 | 3 | 6 | 9 |
| Appendectomy with drainage | 2 * | 2 | 7 | 11 |
| Drainage of appendiceal mass | 2 | 1 | 0 | 4 |
| Drainage with interval appendectomy | 1 | 2 | 3 | 6 |
| Interval appendectomy | 0 | 0 | 2 | 2 |
| No operation | 5 † | 1 | 1 | 7 |
| Total | 10 | 10 | 19 | 39 |
| Mortality rate | 6-60% | 0-0% | 0-0% | 6-15.3% |

* One death.
† Five deaths.

A brief summary of the six deaths follows:

CASE 1.—A 14-month-old white boy with symptoms of 24 hours' duration was hospitalized and treated for 40 days. The diagnosis was scurvy and sepsis of unknown origin. The postmortem examination revealed chronic peritonitis, multiple peritoneal abscesses, multiple gangrenous areas in the small bowel, and mesenteric infarction.

CASE 2.—An 18-month-old white girl with symptoms of seven days' duration was hospitalized for eight days. She had a mass in the right lower quadrant, but she received no surgical therapy. The postmortem examination revealed diffuse peritonitis secondary to a perforated appendicitis, bilateral massive atelectasis, bilateral subphrenic abscesses, and Staphylococcus bacteremia.

CASE 3.—An 18-month-old white boy with symptoms of 36 hours' duration was admitted with a diagnosis of far-advanced bilateral pulmonary tuberculosis and appendiceal abscess. Appendectomy with drainage was performed on day of admission. The operative wound disrupted on the 10th postoperative day. Subsequently left mastoiditis developed, and the patient died on the 24th postoperative day. There was no postmortem examination.

CASE 4.—A 19-month-old Negro girl with symptoms of four days' duration was admitted in the terminal state with temperature of 105 F. She died 12 hours after admission. Necropsy revealed a perforated appendix with diffuse peritonitis.

CASE 5.—A 21-month-old white boy with symptoms of seven days' duration was hospitalized in the terminal state. The temperature was 104.4 F. He died 12 hours after admission. At postmortem examination perforated appendicitis with diffuse peritonitis and bilateral pulmonary edema were observed.

CASE 6.—A 23-month-old Negro girl with symptoms of 24 hours' duration entered the hospital with a diagnosis of pyelitis, confirmed by urine examination. There was no surgical therapy. The patient died eight days after admission. Postmortem examination revealed perforated appendicitis with diffuse peritonitis, active pulmonary tuberculosis, and bronchopneumonia of the right lung.

## COMMENT

All six deaths in the 15-year period (1936-1951) occurred in the first 5-year period (1936-1941). Ten infants had appendiceal peritonitis or an intraperitoneal mass. During these years the only antibiotics available for our use were the early sulfonamide compounds, but there were other factors which influenced greatly the mortality, such as the admission of two patients in a terminal state and the associated active pulmonary tuberculosis of two others. Before 1941, the policy of treating patients with diffuse peritonitis on a conservative basis was accepted by many physicians, and we practiced it for a limited time but were convinced that such a plan did not accomplish a localization of the process. Since 1941, we have advocated primary surgical intervention for appendiceal peritonitis, and of the 29 infants with appendicitis, appendiceal peritonitis, or appendiceal perforation with a localized intraperitoneal mass, 25 have had surgical intervention as primary therapy and only 4 patients were managed under the conservative, or nonoperative, plan. The four patients who were managed conservatively were admitted with inflammatory masses which resolved rapidly with aid of chemotherapeutic agents and supportive measures. There have been no deaths among these 29 consecutive patients during the 10 year period 1941 to 1951.

## SUMMARY AND CONCLUSIONS

1. The triad of abdominal pain, vomiting, and fever in the infant must be considered to be due to appendicitis until proved otherwise.

2. From this study it appears appendicitis is more frequent in the white than in the Negro infant.

3. It appears from this study that appendicitis in the infant is more frequent during the winter and spring months, when upper respiratory infections are more frequent.

4. The mortality of appendicitis and its complications in the infant has shown a marked reduction from 60% during the 5-year period 1936-1941 to 0% during the past 10 years, 1941-1951. This reduction is attributed to the following facts: (*a*) Both parents and physicians are now more cognizant of the fact that appendicitis can occur in the infant. (*b*) There is the realization that surgical intervention is to be emphasized. (*c*) The availability and use of the more potent antibiotics, namely penicillin, streptomycin, and chloramphenicol (chloromycetin®) have played an important role as adjuncts to sound surgical principles in the management of these patients.

5. The cooperation of the attending and the pediatric house staff is highly essential in this group of sick infants.

ADDENDUM

Since the presentation of this paper, four additional infants, aged 12, 14, 20, and 22 months, have been operated upon for acute appendicitis. Three had perforated appendices with local peritonitis and one a gangrenous appendix. All infants recovered satisfactorily.

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## DISCUSSION

Dr. Lawrence Chaffin, Los Angeles: I should like to speak briefly on two phases of the paper read by Dr. Snyder to emphasize features that he did not have time to cover more adequately.

I wish to speak first concerning failure in early diagnosis. As indicated by one of the slides, our present percentage of early diagnoses is no greater than the percentage in 1917 in a series reported by Dr. Abt. Our failure in early diagnosis is evidenced by the fact that in a series of 21 patients, 18 already had ruptured appendixes at the time of surgery, and there were four deaths. In the patients covered in this series, symptoms had existed for three, six, seven, and eight days before surgical attention was requested.

As indicated by Dr. Coury, I believe that respiratory infections and gastroenteritis are the two conditions first considered by the physician in early appendicitis in infants. However, I wish to emphasize that the persistance of nausea, vomiting, muscle spasm, tenderness, abdominal pain, fever, etc., should always indicate surgical intervention in the case of an infant with an acute abdominal condition.

I believe that the abdomen should be examined before the baby has been harassed by other procedures. Inspection of these small patients with all their clothing removed oftentimes gives valuable information. I look for the presence or the absence of abdominal respiratory excursion and the presence or absence of positive signs of abdominal tenderness. Abdominal tenderness is the most important single sign, and, because of the small size of the infant pelvis, bimanual rectal examination gives valuable information. Involuntary muscle spasm, of course, is equally important.

Examination of these patients is of value only if done with care and great patience. Nowhere in surgery will a careful, gentle examination reveal so much worth-while, life-saving information.

In the 15-year period from 1934 to 1950, during which we observed these 21 babies at the Los Angeles Children's Hospital, there were 109 cases of intussusception in the same age group, 42 of Meckel's diverticulum, and 25 of volvulus secondary to malrotation.

Time does not permit a discussion of the differential diagnosis in all these groups. Suffice it to say, however, that I believe the differential diagnosis to be more academic than practical, since all the patients require immediate surgery after proper preparation. This is of paramount importance and accounts very largely for the improved statistics in recent years.

I also wish to emphasize the value of the present use of the antibiotics, pointed out by Dr. Coury. I believe that a continued program with the antibiotics will lessen the mortality rate to approximately zero. Since 1934, when antibiotics first became available, I have had only two deaths, and neither of these should be considered as typical appendicitis. The first child was a 4-month-old baby admitted in 1945 and operated on when 2 days old, without preoperative antibiotic therapy. After operation he had 100,000 units of penicillin every 3 days until death occurred, on the 69th postoperative day. Autopsy revealed hard stool filling the colon, with multiple perforations and acute appendicitis. I believe that the marked intracecal pressure secondary to impacted feces was the cause of death.

The second death was that of a baby 1 month old who was admitted in a moribund state and died 4 hours after entry. Antibiotics were not used. I therefore believe that I have not had a fatality since the regimen outlined by Dr. Snyder has been used. I recognize, of course, that this is not complete proof, but I believe it does indicate that the mortality rate in infants will be materially lowered by the proper use of the presently available antibiotics.

Dr. Howard E. Snyder, Winfield, Kan.: These two papers point out a very important problem, and Dr. Miller's statement that the problem of diagnosis is not so much one requiring further education of a group such as this but of the general practitioner and the pediatrician

certainly applies here. The most important factor in a further reduction of mortality is earlier diagnosis, although adequate preoperative management is also very important, as was so well pointed out by Drs. Snyder and Chaffin in their paper. The administration of antibiotics has certainly changed the mortality rate in this disease.

It is unnecessary to emphasize the program they have outlined regarding fluids and electrolytes in the preoperative period. I think their use of the urinary output as evidence of adequate hydration prior to surgery is an excellent one, and more of us should adopt it.

Another point which might be emphasized is the intravenous use of antibiotics in the preoperative period. I agree with Dr. Chaffin and Dr. Snyder that every case is an operative case as soon as the patient has been adequately prepared for surgery.

DR. EDWIN M. MILLER, Chicago: I think that we will all agree that acute appendicitis in infants is very rare, and we will also agree that in the aged person acute appendicitis is infrequent, but a knowledge of these facts should never permit one to forget that acute appendicitis may occur at any age, even in the baby a few days old. Dr. Snyder has stated that the youngest patient in their series was 7 weeks of age, and I now wish to present 2 lantern slides of a little Negro infant 2 weeks old who, as you can well see from this first photograph, presented the clinical picture of a strangulated right inguinal hernia because of the acute, irreducible, very tender swelling in the right inguinal region. At operation I found the inguinal canal to be filled with pus, and in it lay a large acutely inflamed, gangrenous ruptured appendix. The cecum, fortunately, had become wedged into the canal at the internal ring, thus effectively sealing off the general peritoneal cavity. After the removal of the appendix and the establishment of free drainage, this little baby made a rapid uneventful recovery.

There is one respect in which I should like to differ with Dr. Benson and his associates and that is in the treatment of the little patient who presents the clinical picture of the so-called localized appendiceal abscess. Too often, I think, surgeons are too prone to operate on these patients in order to remove the appendix, but in our experience, which covers a period of many years of surgery on children, it is a much wiser plan, as a general rule, to follow a very conservative course. A palpable inflammatory mass of this type, whether it be located in the right lower abdominal quadrant or deep in the pelvis, or in some abnormal position, represents a slow leak from the appendix against which has been built up an adequate defense mechanism. If left alone and carefully watched, the vast majority of such inflammatory masses (as we have shown in our report in *The Journal of the American Medical Association* in 1940, following a personal study of over 1,000 cases of acute appendicitis in children) will gradually diminish in size and after a few weeks entirely disappear. Only a small per cent of such masses will take the opposite course and, because of their rapidly increasing size with the accompanying acute clinical symptoms, demand surgical drainage, which if properly carried out far to the lateral side of the mass can be accomplished without soiling the general peritoneal cavity. After these patients have recovered and all symptoms of the disease have subsided—after an interval of perhaps two or three months—these patients can be returned to the hospital and the appendix can be safely removed no matter how extensively it may be involved in adhesions or how abnormal its position may be in the abdomen.

As I have said, it is upon this point only that I would differ with Dr. Benson and his colleagues in their excellent paper.

DR. THOMAS J. SNODGRASS, Janesville, Wis.: In Rock County, Wisconsin, we surveyed 8,000 cases of appendicitis, over a 34-year period, and I was interested to find how many of the patients were under 2 years of age. In the first group, of 6,800 patients, there were 373 cases of appendicitis in children under 9 years of age, with 17 deaths. The work sheets did not make any additional statistical breakdown, but in the second group, of 1,700 cases of appendicitis studied, there were 5 appendectomies in children under 2 years of age, with no deaths. One patient was 8 months old, with an acutely inflamed appendix; one was 8 months old, with a ruptured appendix, and in one the appendix was removed in connection with a strangulated hernia, such as Dr. Miller has just illustrated. The other 2 patients, one 18 months old and one 20 months of age, had appendectomies at the time of repair of a hernia. I thought you might be interested in the incidence of appendicitis in children in a survey of this type.

DR. DEAN SAUER, St. Louis: There is no question that mortality rates are decreasing in this disease. However, it is obvious from the previous remarks that a great deal of the credit

has been given to the antibiotics. I believe we should also give a great deal of additional credit to the physician-anesthesiologist who sees to it that we are using the proper amount of oxygen and the proper amount of fluid through the parenteral administration of greater amounts of blood and electrolytes. The latter in itself is a very potent factor in lowering the mortality rate, coupled with a better and more comprehensive knowledge of the water and electrolyte balance and a better appreciation of the concomitant potassium depletion in these patients. So, if I may, I should like to stress that point.

With respect to one other phase of Dr. Coury's presentation, I believe we can agree with him that occasional attempts may be made to resolve the abscess without operation. However, in a critically ill patient it may become evident that treatment must be surgical, but still only after adequate preparation. Dr. Coury has said that there are a certain number of patients on whom it may not be necessary to perform appendectomies. This is very interesting because a child with an already developed abscess, to my mind, is one who probably has a very great peritoneal immunity, and so we are dealing with a problem that is already local. When one has an appendiceal abscess and it is entered, one should plan to decrease the ever-continuing peritoneal contamination, and the only way one can do that is by an appendectomy. I feel the additional time required to do the procedure with its obvious advantages far outweighs the slight, if any, additional danger to which one may submit one's patient.

Dr. Eugene A. Osius, Detroit: I have been very interested in this subject, as Dr. Benson and I work in the same institution, and I have had close contact with some of the cases reported. We have learned to have considerable respect for a mass in the right lower abdominal quadrant. I also have a great deal of respect for Dr. E. Miller's judgment, which has extended over many years and a vast experience. But my own personal experience with two cases of such masses which we were hoping to resolve colors my reaction. While two patients with masses were being watched, they died within a few hours because of rupture of that abscess and generalized peritonitis and shock. This has made us somewhat chary of waiting too long before operative intervention is carried out. We feel that any mass in the right lower quadrant means that the patient should be examined at least once in eight hours, and examined most gently. If there is the least hint that the mass is increasing in size, as delineated by marking the size of the mass on the abdominal wall with an easily seen dye, the abscess should be opened and drained. We feel that the danger of inability properly to wall off such an abscess in a child is greater than the danger of surgery, in our own personal experience.

Dr. John H. Woolsey, Woodland, Calif.: Dr. Fred H. Fairchild, my associate and a member of the Western Surgical Association, has addressed you on several occasions on the subject of acute appendicitis. Owing to his leadership we have had a special interest in this condition. Our fatalities in appendicitis occurred in the very young and in the aged. Early diagnosis, as stressed by the authors of both papers, we also believe is most important.

In making the early diagnosis, I should like to emphasize the following three points: First, the general behavior of an infant or child is of importance. With peritoneal irritation as with appendicitis, the patient lies quietly with his legs flexed and protects his abdomen, in contrast his very active conduct with a gastroenteritis per se or a respiratory infection. Second, auscultation of the abdomen for presence or absence of peristalsis is important. In peritoneal irritation we have the conditioned reflex of an absence of peristalsis, whereas with an enteritis there is an increased peristaltic action. Third, palpation of the abdomen with warm hands, at times stealthily done with the patient asleep, will give findings of importance not obtainable with the awakened irritable child.

There are time when drainage only, like marsupialization, has proved a life-saving procedure.

# PANCREATIC CALCIFICATIONS

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PANCREATIC calcifications take the form either of true pancreatic calculi, which are present in the ducts, or of a diffuse pancreatic calcinosis, with a deposition of calcium scattered throughout various segments of the gland. These calcifications are considered to be a late phase of chronic relapsing pancreatitis [1] and may or may not be associated with extensive fibrosis of the gland, diabetes, and steatorrhea. Pancreatic cysts may occur, but they are more common following acute pancreatitis.

Abdominal pain is the chief complaint of the majority of patients with pancreatic calcifications, and most types of treatment are aimed, either directly or indirectly, toward the relief of this symptom. Unilateral splanchnicectomy has been successful in the relief of pain of pancreatic origin.[2] The reason for this is not clear, as the innervation of the pancreas is bilateral within the sympathetic system.[3] If, however, a unilateral splanchnic block with procaine produces relief of pain, then a unilateral splanchnicectomy is indicated. If the pain recurs on the opposite side, a contralateral splanchnicectomy may be done. The excellent results reported following splanchnicectomy for fibrocystic disease of the pancreas [4] indicate that a physiological response occurs in addition to the interruption of the pain fibers. Sympathectomy, likewise, will give effective relief of pancreatic pain.[3] Many other surgical procedures have been advocated for the treatment of this condition, but no attempt will be made here to discuss them.

Forty cases of pancreatic calcifications were seen at the University Hospital from 1935 to 1951. Of this group 10 patients, or 25%, were admitted for other disease conditions and had no symptoms referable to the pancreas; the calcifications were discovered either on routine x-ray studies or at autopsy. The remaining 30 patients, or 75%, were admitted to the hospital with the chief complaint of abdominal pain, and the diagnosis was either made or confirmed by x-ray studies. The duration of

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From the Department of Surgery, University of Wisconsin Medical School, Madison, Wis.

Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

1. Comfort, M. W.; Gambill, E. C., and Baggenstoss, A. H.: Chronic Relapsing Pancreatitis, Gastroenterology **6**:239, 1946

2. de Takats, G., and Walter, L. E.: The Treatment of Pancreatic Pain by Splanchnic Nerve Section, Surg., Gynec. & Obst. **85**:742, 1947.

3. Ray, B. S., and Console, A. D.: The Relief of Pain in Chronic (Calcareous) Pancreatitis by Sympathectomy, Surg., Gynec. & Obst. **89**:1, 1949.

4. Ayers, W. B.: The Treatment of Fibrocystic Disease of the Pancreas and Associated Bronchial Lesions by Splanchnicectomy, J. Internat. chir. **10**:146, 1950.

symptoms varied from 6 weeks to 17 years. There were 28 men and 12 women in the series. This ratio is the reverse of that found in gall-bladder disease. The youngest patient was 24 years of age and the oldest 87 years of age. A history of alcoholism

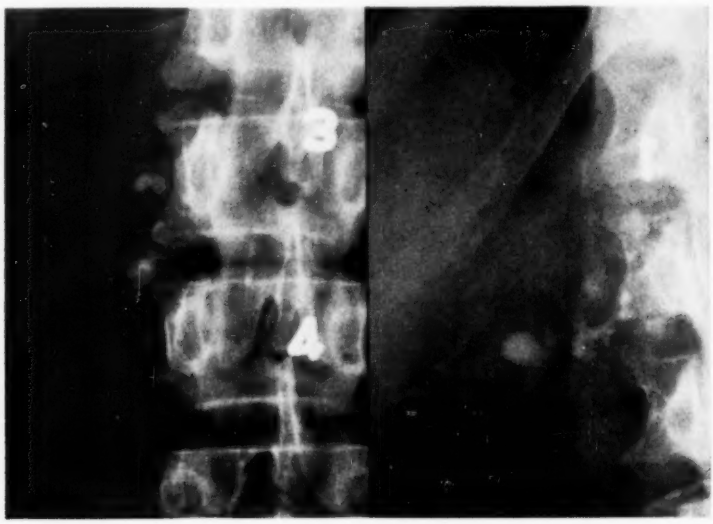

Fig. 1.—Pancreatic calculi.

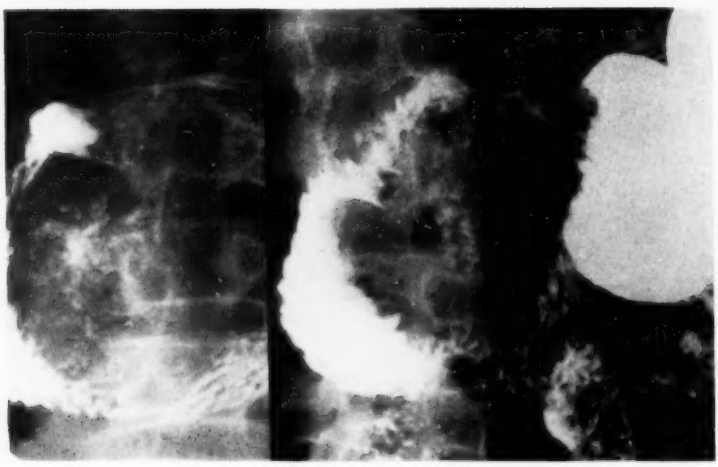

Fig. 2.—Diffuse pancreatic calcinosis.

was obtained in 13 cases, but it was difficult in some cases to determine whether or not the excessive use of alcohol preceded the onset of the pain. Six of the patients were morphine addicts; this made evaluation of the results of their treatment difficult.

Eight of the patients had definite cholecystic disease; of these two had had previous cholecystectomy and six showed gallstones on cholecystograms. Six patients had subnormally functioning gall bladders, but no gallstones were visualized. In seven patients the status of the gall bladder was undetermined. In the remaining 19 cholecystography or exploration showed that the gall bladder was normal.

There were nine diabetics in this series, and steatorrhea was present in 11 cases. One patient was reported to have had a pancreatic cyst drained prior to admission to the University Hospital.

Eleven of the patients had a total of 14 operations upon the pancreas or the biliary tract for the relief of their symptoms. Only one was permanently relieved of his pain.

In each of the following eight cases either a unilateral or a bilateral supradiaphragmatic sympathectomy or splanchnicectomy was done.

*Type of Operations*

| No. | Type | Results |
|---|---|---|
| 1 | Cholecystostomy | No improvement |
| 1 | Cholecystojejunostomy | No improvement |
| 2 | Cholecystectomy | No improvement |
| 2 | Cholecystectomy and choledochotomy | Temporary improvement |
| 3 | Exploration with biopsy of pancreas | No improvement |
| 1 | Incision of head of pancreas with removal of stones | No improvement |
| 1 | Aspiration and exploration of enlarged pancreatic duct—no stones found | No improvement |
| 1 | Drainage of pancreatic cyst | Temporary improvement |
| 1 | Resection of body and tail of pancreas | No improvement |
| 1 | Radical pancreatoduodenal resection (Whipple) | Pain relieved |

CASE REPORTS

CASE 1.—A 63-year-old white man entered the hospital on March 4, 1948, with the complaint of epigastric pain since May of 1947. The pain was sharp and cramp-like and was often brought on by eating. His stools were normal. Diabetes was first discovered in October of 1947 and was controlled by dietary means alone. During the previous year the patient had lost 13 lb. (5.9 kg.) in weight. There was voluntary rigidity of the abdomen with tenderness localized in the right upper quadrant, but no masses were palpable. The white blood cell count was 10,800. The results of urinalysis were negative. The blood sugar was 202 mg. per 100 cc. The icterus index was 6 units. The serum amylase was 73 units. The reaction to the Hanger test was negative. The thymol turbidity was 0. A cholecystogram showed a normally functioning gall bladder without stones. X-ray study following a barium enema revealed nothing abnormal. Gastrointestinal x-ray examination showed the duodenal loop to be distinctly enlarged and rounded, with evidence of a mass in the region of the pancreatic head. There were calcareous shadows in the region of the upper lumbar vertebral bodies, with most of these shadows directly overlying the spine but a few extending to either side. On March 11, 1948, a bilateral sympathetic block of the 11th thoracic ganglion with dibucaine (nupercaine®) hydrochloride produced complete relief of pain for over four hours. On March 16, 1948, a bilateral supradiaphragmatic sympathectomy was done. This included the 10th to 12th thoracic ganglia, with resection of major and minor splanchnic nerves. After surgery the patient was completely relieved of abdominal pain, but he complained of some pain at the site of his incisions. He was discharged on April 22, 1948. Follow-up three and a half years later reveals that he has had no recurrence of his abdominal pain. He is still on a diabetic diet and is taking 25 units of regular insulin a day. An intermittent diarrhea has developed, with loose, light-colored stools, lasting for four to eight weeks and then subsiding.

CASE 2.—A 43-year-old white man entered the hospital on Dec. 8, 1948, with the complaint of pain in the abdomen. His pain was first noticed in March of 1948. The pain was dull and gnawing in character, unchanged by meals, and would radiate into his back, keeping him awake at night. He had tried ulcer treatment without relief of symptoms. He had a history of a perforation of an asymptomatic duodenal ulcer in 1943. There had been a 50-lb. (22.7 kg.) weight loss since July of 1948. His bowels were regular but his stools were somewhat light-colored and soft. There was a supraumbilical midline scar with a large incisional hernia. A tender mass 4 cm. in diameter was palpated just to the right of the midline in the epigastric region. The blood pressure was 182/140. The white blood cell count was 7,250, with a normal differential count. The urine was negative for sugar and acetone but showed traces of albumin. The result of the phenolsulfonphthalein test was 5% the first half hour and 18% at the end of two hours. The nonprotein nitrogen was 45 mg. per 100 cc., with a creatinine content of 1.6 mg. per 100 cc. The blood sugar was 90 mg. per 100 cc. The blood serology was negative. The icterus index was not determined. The serum amylase was 87 units. The reaction to the Hanger test was negative. The thymol turbidity was 1 unit. The gall bladder did not concentrate sufficient medium to be visualized. Results of the barium enema study were noncontributory. Gastrointestinal x-ray examination revealed no intrinsic deformity of the esophagus and stomach. There was considerable enlargement of the duodenal curve with evidence of pressure on the ascending portions. There was a collection of irregular calcareous densities lying within the duodenal curve, and a mass was palpated in this region. On Dec. 21, 1948, a left supradiaphragmatic resection of the greater and lesser splanchnic nerves was done. The patient obtained complete relief of his pain and was discharged from the hospital on Dec. 29, 1948. There was no improvement of the hypertension following this unilateral splanchnicectomy. The patient died at home on Feb. 14, 1949. The cause of death was uremia secondary to renal failure. There had been no recurrence of pain up to the time of his death.

CASE 3.—A 48-year-old white man was admitted to the hospital on April 19, 1949, with the complaint of pain in the epigastric region. The pain was initiated by eating and persisted as a burning sensation extending through to the back. The pain began about six months prior to his admission to the hospital. He had lost 30 lb. (13.6 kg.) since the onset of his symptoms. He was constipated. His abdomen was flat. There was moderate tenderness in the epigastrium and just to the left of the midline. No masses were palpable. The results of urinalysis were negative. The white blood cell count was 13,750, with 65% neutrophiles, 23% lymphocytes, 7% monocytes, 4% eosinophiles, and 1% basophiles. The blood sugar was 93 mg. per 100 cc. The nonprotein nitrogen was 36 mg. per 100 cc. The Wassermann reaction was negative. There are no records of other special laboratory studies. The flat plate of the abdomen revealed a large amount of granular calcification extending obliquely across the upper abdomen from the right margin of the second lumbar vertebra toward the level of the 11th rib on the left side. On April 20, 1949, a diagnostic block of the right splanchnic nerves produced a remission of pain for approximately one-half hour. On May 5, 1949, a right supradiaphragmatic resection of the thoracic sympathetic chain from the tenth thoracic to the second lumbar segment, including the splanchnic nerves, was done. Following this the patient was completely relieved of his abdominal pain, but on discharge from the hospital he still had pain at the site of operation. A recent check-up revealed that the severe right pancreatic pains were relieved to some extent, but there was still some pain on the left side one or two days each week. Also, there was pain at the site of operation. The patient was advised to return for left splanchnic resection, but up to this time has not returned. He has no diarrhea and does not have diabetes.

CASE 4.—A white man, aged 36, entered the hospital on July 25, 1949, with the complaint of severe upper abdominal pain of 17 years' duration. The attacks were not associated with nausea or vomiting, but diarrhea was frequent. The pain was so severe that during 1935 and 1936 he became a morphine addict; and, although he had "taken the cure," the pain still required the use of opiates. There was no radiation of the pain. He had tried alcohol for the relief of pain with little success. He had had 22 hospital admissions during the 17-year period. His weight had remained about stable. There was no evidence of diabetes. His blood pressure was normal. The abdomen was slightly rounded. There was a right lower quadrant appendectomy scar. No masses were palpable, and there was no tenderness. The results of urinalysis were negative. The white blood cell count was 9,900, with a normal differential distribution. The

blood sugar was 115 mg. per 100 cc., and the nonprotein nitrogen was 21 mg. per 100 cc. The serum amylase varied between 86 and 141 units. The result of the Hanger test was negative. The thymol turbidity was 2 units. The prothrombin time was 100%. A cholecystogram revealed a normally functioning gall bladder without stones. The gastrointestinal x-ray examination revealed no pathological condition. A number of small calcareous densities were observed, which were believed to lie in the pancreas. X-ray study following a barium enema showed no abnormality. On Aug. 1, 1949, bilateral supradiaphragmatic sympathectomy and splanchnic resection were done. The sympathetic trunk from the ninth to the twelfth thoracic ganglion, inclusive, was removed, as well as the splanchnic nerves. Following surgery pain developed in the incisions, but the abdominal pain had disappeared, and the patient was discharged on Aug. 11, 1949. He did not have recurrence of his abdominal pain but complained of pain in his lumbar region over the fourth or fifth lumbar ganglion. He was readmitted to the hospital on Feb. 26, 1951, and x-rays showed a narrowing of the fourth lumbar disk space with a small amount of sclerosis of the contiguous bone surfaces. A pantopaque® myelogram showed a filling defect at the fourth lumbar intervertebral disk. On March 13, 1951, a lumbar laminectomy was performed. The deformity was produced by a thickened ligamentum flavum at the fourth lumbar interspace. There was constriction of the dural sac at this point, and after decompression the dural sac was opened. There were subdural and subarachnoid adhesions, but no evidence of a tumor. The patient was discharged on April 3, 1951. He was readmitted on Aug. 22, 1951, with a new type of pain over the right sacrum and coccyx. He stated that he had been entirely free of pain until about June 28, when, while working on his farm, he fell against a wooden beam and struck his back. After this he noticed a recurrence of his old pain in the back and also a severe sharp radiating pain going down the posterolateral aspect of the right thigh and leg to the heel. This was worse on straining or coughing. The pain became so severe that he took an opium alkaloid mixture (pantopon®) for relief of pain. Examination revealed no change in the neurological pattern. X-ray study showed no increase in the degenerative disease of the fourth lumbar disk and only minute residue of iodized oil in the lumbar canal. In view of the history of drug addiction and the lack of increased neurological findings, a prefrontal lobotomy was advised. This was performed on Sept. 4, 1951, and was limited to the right side. After surgery the patient received only acetylsalicylic acid for the relief of headache, and at the time of discharge volunteered the information that he was much improved. He was cheerful and hopeful. He has not been seen since his discharge.

CASE 5.—A 40-year-old white man entered the hospital on July 17, 1949, with the complaint of upper abdominal pain since 1939. A tentative diagnosis of carcinoma of the pancreas was made in 1942, but on exploration a chronic pancreatitis with pancreatic calculi was found to be present, and a resection of the body and tail of the pancreas was done. This did not relieve the patient's pain, and drug addiction developed to morphine, methadone, and meperidine (demerol®). In addition, he had used alcohol to excess in an attempt to relieve the pain. He has had two other explorations since that time for the same type of pain. Both times biopsies of pancreas and lymph nodes in the adjacent area did not reveal malignancy. Later a chronic cough developed. There was no history of diabetes, and stools were normal. Examination of the chest revealed some dullness, with rales in the right apex. The abdomen was slightly rounded, and three abdominal incisions were present. There was moderate epigastric tenderness with a mass in the midline in the epigastrium. The blood count was normal. The urine was normal. The blood chemistry was within normal range. The Wassermann reaction was negative. A chest x-ray examination revealed moderately advanced tuberculosis of the right upper lobe. A flat plate of the abdomen revealed a cluster of granular calcifications overlying the region of the second and third lumbar vertebrae in the region of the head of the pancreas. On Dec. 10, 1949, a left splanchnicectomy was done with apparent improvement of the patient's pain, although because of his addiction it was difficult to evaluate this. He was discharged to Lakeview Sanatorium for treatment of his tuberculosis. The tuberculosis was arrested, and he was discharged from the sanatorium on June 19, 1950, and felt well except for slight discomfort around his incision. However, two weeks before admission to the hospital the pain recurred in the epigastrium. He was readmitted on Sept. 10, 1950. X-rays at this time revealed some increase in the number of stones since the examination of Nov. 19, 1949. On Sept. 12, 1950, a right splanchnic resection was done. The patient was discharged on Sept. 18, 1950, without complete relief of his pain.

The pain in the incision was much more severe than that in his abdomen. At last report, October, 1951, the patient still complained of some dull abdominal pain. However, in view of his addiction, which is still present, it is difficult to evaluate his symptoms.

Case 6.—A 31-year-old white man entered the hospital on May 29, 1951, with the complaint of pain in the stomach and back which began in the fall of 1949. The pain was precipitated by fatty foods and was characterized by excessive gas, nausea, and occasional vomiting. The pain became progressively worse in spite of a restricted diet, and radiated through to the back. There was a 60-lb. (27.2 kg.) weight loss over a period of eight months. There was a long history of excessive alcohol intake. The abdominal examination revealed the presence of some tenderness in the epigastric region, and the liver was enlarged 2 cm. below the right costal margin. The findings on urinalysis and blood counts were within normal range. The blood sugar was 102 mg. per 100 cc. The nonprotein nitrogen was 37 mg. per 100 cc. The icterus index was 6 units. The serum amylase was 23 units. The reaction to Hanger's test was negative. The result of the thymol turbidity test was negative, and the prothrombin time was 100%. A cholecystogram revealed a normally functioning gall bladder without stones. The barium enema was negative. An upper gastrointestinal series revealed the esophagus, stomach, and duodenum to be normal. Pancreatic calculi were visualized in the midabdomen, best seen at the disk level between the second and third lumbar vertebrae. On June 7, 1951, a left splanchnic block was done with 65 cc. of 0.5% piperocaine (metycaine®), with some subjective relief of the pain. On June 16, 1951, a left supradiaphragmatic splanchnicectomy was done. After surgery the patient noted that the typical epigastric pain was no longer present, although he did have some pain at the operative site. He was discharged on June 23, 1951, relieved of his pain. A follow-up four months later revealed that he still had no recurrence of his original pain, although his incisional area was still somewhat tender.

Case 7.—A 36-year-old white man entered the hospital on June 25, 1951, with the complaint of pain in the right upper abdomen. This began in 1943. He had had almost continuous pain for the previous six weeks and required as much as three "shots" of morphine for relief of pain. When he had the pain, his stools became somewhat looser than normal but were still formed. He had avoided fatty foods. He had a moderate alcohol intake, and had lost 7 to 8 lb. (3.2 to 3.6 kg.) in the previous six weeks. He had had surgery for peptic ulcer in 1942, with temporary relief of symptoms. The abdominal examination revealed a scar of the previous surgical incision. There was moderate tenderness in the epigastric region. The blood count and urine were within normal limits. The nonprotein nitrogen was normal. The blood Wassermann reaction was negative. The blood sugar was elevated, ranging from 130 to 156 mg. per 100 cc. The serum amylase was 64 units. The glucose tolerance curve was abnormal. The fasting blood sugar was 260 mg., rising to a high of 332 mg., with a late fall to a low of 136 mg. per 100 cc. The gastrointestinal x-ray examination revealed some irregularity along the superior aspect of the duodenal bulb. Because of calcareous densities in the area of irregularity the change was believed to be due to pancreatitis. These same densities were visualized by means of a normal barium enema. A cholecystogram revealed a normally functioning gall bladder without stones. The patient was discharged on June 30, 1951, and readmitted on July 18, 1951, for surgery. On July 19, 1951, a right supradiaphragmatic splanchnic resection was done. The pleura, which was inadvertently opened, was resutured without difficulty. After surgery the patient claimed complete relief of his abdominal pain, but he still complained of some pain in his incision upon discharge on July 21, 1951. He was readmitted on Oct. 2, 1951, because of development of weakness, anorexia, polydipsia, and a 20-lb. (9.1 kg.) weight loss. He had had no recurrence of his abdominal pain. Laboratory studies revealed sugar in the urine (4+) and a blood sugar level of 314 mg. per 100 cc. He was discharged on Oct. 10, 1951, and given a dietary regimen plus 35 units of NPH insulin daily.

Case 8.—A 48-year-old white man entered the hospital on Aug. 13, 1951, with the complaint of pain in the right side which radiated to the back. This pain had been present for five or six years. Fatty and fried foods aggravated the pain. There was a history of chronic alcoholism. He had lost 10 lb. (4.5 kg.) in weight prior to admission to the hospital. The abdominal examination revealed some tenderness in the epigastric region. The liver edge was palpable but did not appear to be nodular. The blood count and urine were normal. The blood sugar was 104 mg. per 100 cc. The nonprotein nitrogen was 35 mg. per 100 cc. The serum amylase was 64 units.

Reaction to the Hanger test was negative. The prothrombin time was 100%. The glucose tolerance test was within normal range. A cholecystogram showed a subnormally functioning gall bladder without evidence of stones. The gastrointestinal x-ray examination revealed a normal esophagus, stomach, and duodenum, but there were numerous scattered areas of hazy calcification overlying the pancreatic region, representing calculi within the pancreas. On Aug. 18, 1951, a right supradiaphragmatic sympathectomy from the seventh to the twelfth thoracic ganglion, with resection of the greater and lesser splanchnic trunks, was done. The patient obtained complete relief of his abdominal pain but did have pain in the incision when discharged on Aug. 25, 1951. He was last seen in the outpatient clinic on Oct. 15, 1951. He had no recurrence of his abdominal pain, and the pain in his back had decreased.

SUMMARY

Of the eight patients, four are free of pain three months to three and a half years after sympathectomy or splanchnicectomy. One patient died of uremia and renal failure three months after a unilateral sympathectomy without recurrence of his pain. One patient has had a return of pain to his left side after a right sympathectomy, but refuses further surgery. In one patient low-back pain developed, necessitating a laminectomy and later a prefrontal lobotomy for relief of this pain. He stated that his abdominal pain disappeared after a bilateral sympathectomy and splanchnicectomy, but he was not cured of his addiction and low-back pain until after the lobotomy. In the last patient, also an addict, pulmonary tuberculosis developed after he had had a left and later a right splanchnicectomy. He claimed that he obtained relief of the severe pain but that a dull ache persisted. Because of his addiction, no definite conclusion as to the final result was possible.

## DISCUSSION

Dr. Arkell M. Vaughn, Chicago: I should like to present a case of diffuse calcifications of the pancreas from our service at Mercy Hospital. The patient was a 40-year-old man who was admitted because of the possibility of gastrointestinal malignant disease. His symptoms were generalized cramp-like abdominal pain, marked loss of weight, frequent, soft stools, and malaise. The stool on microscopic examination showed a large number of fat globules and undigested food particles. Blood plasma studies and a succession of serum amylase determinations were done, and he had an x-ray examination, during the course of which diffuse calcifications of the pancreas were seen.

[Slide] This wasn't the best slide we had, but here [indicating] is a calcification, and these are anteroposterior views instead of the oblique.

[Slide] Again this shows a calcification in the tail of the pancreas. This man had a severe anemia, and he was given sorethytan (20) monooleate (sorlate,® Abbott), which is a wetting agent used in breaking up the fat globules as an aid in digestion. He was also given a preparation containing pepsin, pancreatin, and bile salts (entozyme®), and vitamins A and D, the fat-soluble vitamins. When I saw him he had only a mild type of pain and I did not think it was severe enough for surgery. He has gone home and has regained his former weight. He joined Alcoholics Anonymous, and still has not resigned from Alcoholics Anonymous as far as I know.

Dr. Chester C. Guy, Chicago: In the last three years we have had six patients with painful pancreatic disease for which we have performed either unilateral or bilateral splanchnicectomies. The diagnosis for all six patients had been confirmed by exploratory laparotomy. Three of these suffered from sclerosing pancreatitis with calcifications. One of them obtained complete relief after bilateral splanchnicectomy, one complete relief after unilateral splanchnicectomy, and one has obtained very marked relief after bilateral splanchnicectomy. This last patient prior to operation required narcotics in considerable amounts, but is now relieved of drug addiction.

During this same period, we have had three patients with proved carcinoma of the body of the pancreas, who complained of severe epigastric pain radiating into the back. All three were in

generally good physical condition. These patients were subjected to bilateral splanchnicectomy for the relief of pain. Two of them obtained some relief but only for one or two months; the third patient was not benefited.

I should like to emphasize that splanchnicectomy may be of great value in sclerosing pancreatitis, but it is not indicated for the relief of pain in carcinoma of the pancreas.

DR. ERWIN R. SCHMIDT, Madison, Wis.: This represents the stark tragedy in the life of any human being. One of the things that seems to me so very important is the fact that in these patients the disease is not diagnosed for a long time. As a result they end, as Dr. Lemmer indicated, either in alcoholism or addiction. As he said, we don't have the answer for the problem, but I think we should watch for the diagnosis so that these poor people will at least get a diagnosis.

DR. KENNETH E. LEMMER, Madison, Wis.: I wish to thank the discussers. I think the point brought out by Dr. Guy has been explained by Dr. de Takats, namely, that the pain from a carcinoma which extends beyond the pancreas is a somatic type of pain rather than that carried by the splanchnic nerves. Therefore, the pain of carcinoma is probably not much relieved by splanchnic resection. Just so we don't get the idea that all calcifications in this region are due to pancreatic calculi, I have one slide which I should like to show you.

[Slide] This patient came in because of epigastric pain, and, as you can see, there are multiple areas of calcification in the region of the pancreas. His gastrointestinal x-ray, however, reveals a duodenal ulcer and the calcification is not located in the curve of the duodenum or region of the pancreas but around the celiac axis and originates in the regional lymph nodes. The patient was completely relieved of his pain by gastric resection.

# INTESTINAL-BILIARY REFLUX AFTER ANASTOMOSIS OF COMMON DUCT TO DUODENUM OR JEJUNUM

## An Experimental Study

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THE IMPORTANCE of reflux of intestinal content into the biliary tract as a cause of ascending cholangitis and biliary cirrhosis following anastomosis between the biliary and the gastrointestinal tracts has been a subject of discussion for some time. With the hope of adding to our knowledge of this subject, three different surgical procedures have been performed on three groups of dogs, in which cholecystectomy and stricture of the common duct had previously been accomplished. In the first group, side-to-side choledochoduodenostomy was performed. In the second group, side-to-side choledochojejunostomy was carried out between the duct and an intact loop of jejunum. In the third group, side-to-side choledochojejunostomy was established in a so-called defunctionalized or antiperistaltic limb of jejunum after the method of Roux.

### METHODS

All dogs had preliminary cholecystectomy and partial occlusion of the common duct. The latter procedure was carried out by crushing the distal portion of the common duct with a hemostat and then tying a silk ligature around the crushed duct and a stout curved needle, the needle then being removed. Thus a small aperture in the traumatized portion of duct was left for bile to enter the intestine. Biopsy of the liver and culture of the gall-bladder bile were taken at the time of each operation, and the dog's weight was charted. Ten to 12 weeks following this preliminary procedure, when the common duct was distended to several times its normal diameter, biliary-intestinal anastomosis was performed by one of the three methods (Figs. 1, 2, 3). Each anastomosis was slightly over 1 cm. in diameter. An outer row of interrupted surgical silk sutures was used, with an inner row of continuous surgical sutures of 0000 chromic gut. All the anastomoses were side-to-side and made in the same manner. At the time the anastomosis was made the common duct was ligated at the site of the stricture, biopsy of the liver was performed, a culture was made of material taken from the common bile duct, and a sample of blood was drawn for estimation of bilirubin.

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From the Lovelace Clinic, Albuquerque, N. M. (Dr. Musgrove), and the Division of Experimental Medicine, Mayo Foundation, University of Minnesota (Dr. Grindlay and Dr. Karlson).

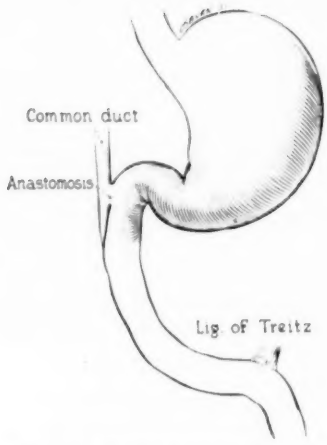


Fig. 1.—Choledochoduodenostomy.

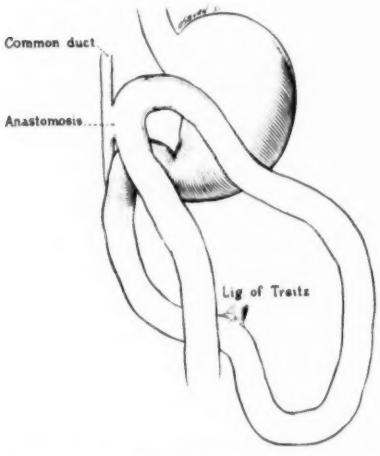


Fig. 2.—Choledochojejunostomy with intact loop of jejunum.

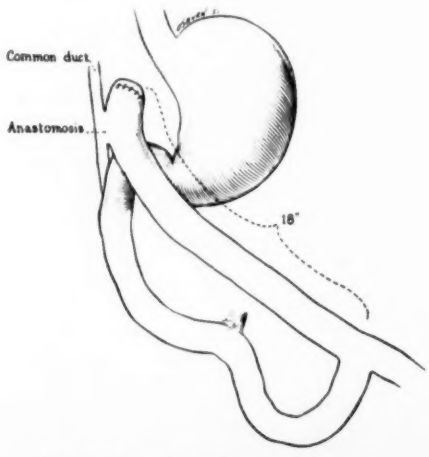


Fig. 3.—Roux-Y choledochojejunostomy.

The weight of each dog was recorded at weekly intervals. Several weeks to months following the biliary-intestinal anastomosis, each dog was given a barium gavage when the stomach was empty, and a series of roentgenograms were made in the next 24 hours in an attempt to determine the presence of biliary reflux.

One dog from each group was killed under anesthesia six months after the biliary-intestinal anastomosis and another one year after the procedure. The remaining dogs of each group were anesthetized and killed at various times, most of them from one to two and one-half years following anastomosis. Two to three hours before final examination the dogs were given a fat meal and a large gelatin capsule containing lampblack. The dogs were then anesthetized, the abdomens opened aseptically, and the viscera and anastomoses carefully inspected. At the time of necropsy, photographs, both in color and black and white, were made of the opened common duct and bowel in the region of anastomosis and of the lymph vessels of this region. Each dog was weighed; a sample of blood was taken for estimation of bilirubin; bile was removed from

TABLE 1.—*Weight of Dogs in Kilograms*

| Type of Anastomosis | Dog | Before Stricture | At Time of Anastomosis | At Necropsy |
|---|---|---|---|---|
| Choledochoduodenostomy | 1 | 13.3 | 14.1 | 16.1 |
| | 2 | 11.6 | 11.4 | 11.0 |
| | 3 | 11.3 | 10.3 | 10.3 |
| | 4 | 13.3 | 14.1 | 16.1 |
| | 5 | 16.0 | 14.7 | 18.2 |
| | 6 | 20.6 | 21.5 | 29.0 |
| Choledochojejunostomy (loop) | 7 | 16.7 | 17.0 | 17.2 |
| | 8 | 14.6 | 16.9 | 14.1 |
| | 9 | 17.8 | 17.3 | 18.0 |
| | 10 | 17.4 | 16.3 | 12.1 |
| | 11 | 11.7 | 13.0 | 15.2 |
| Choledochojejunostomy (Roux-Y) | 12 | 15.0 | 16.2 | 15.6 |
| | 13 | 18.1 | 20.7 | 19.0 |
| | 14 | 17.2 | 17.3 | 12.4 |
| | 15 | 17.2 | 16.7 | 16.5 |
| | 16 | 14.2 | 15.5 | 12.7 |
| | 17 | 15.3 | 16.3 | 14.2 |
| | 18 | 14.7 | 14.4 | 17.2 |

the common duct and cultured, and portions of the liver, intrahepatic duct, and the area of anastomosis were removed for histologic examination.

## RESULTS

*Weight.*—Weights are given in Table 1. When the weight at the time of the biliary-intestinal anastomosis is compared with the weight at necropsy, it can be seen that in many animals of each group the type of anastomosis did not influence weight to any great extent. Significant loss of weight occurred in one dog (Dog 10) on which loop choledochojejunostomy had been carried out, and in three dogs (Dogs 14, 16 and 17) which had undergone Roux-Y choledochojejunostomy.

*Roentgenographic Findings.*—The roentgenographic studies made after the various biliary-intestinal anastomoses were of considerable interest. None of the dogs with the Roux-Y choledochojejunal anastomoses showed any evidence of barium within the biliary tree, whereas roentgenograms of all of the dogs in the other two groups showed barium in the intrahepatic bile ducts. The barium entered the bile ducts much more freely after loop choledochojejunostomy than after choledocho-

duodenostomy (Fig. 4). Four of the dogs still had barium in the intrahepatic ducts 24 hours after the gavage, three of these four had loop choledochojejunal stomas, and one had a choledochoduodenal stoma.

*Serum Bilirubin.*—Estimations of serum bilirubin made at the time of biliary-intestinal anastomosis and again just prior to necropsy were of value in a negative manner. Dog serum normally does not contain any direct-acting bilirubin while the value for indirect-acting bilirubin is usually less than 0.1 mg. per 100 cc., but under some conditions, as with a prolonged fast, it may rise to 0.7 mg. per 100 cc. Two of the indirect-acting bilirubin estimations were elevated, but both were unreliable owing to slight hemolysis; the remainder of the bilirubin estimations were within normal limits. None of the dogs showed clinical evidence of jaundice, and the levels of the bilirubin support this clinical finding.

Fig. 4.—Roentgenogram of Dog 2, with choledochoduodenal anastomosis, showing biliary tree outlined by barium.

## NECROPSY

*Anastomosis.*—All but one of the biliary-intestinal stomas were widely patent. In Dog 11 the loop choledochojejunal stoma was constricted to the extent that it would barely admit a 2 mm. probe.

*Extrahepatic Bile Ducts.*—Dog 11 again was the only one showing any gross abnormality of the extrahepatic bile ducts. There was considerable scarring about the common duct and the porta hepatis, and a 2 mm. probe could be passed only 2 cm. above anastomosis. It was difficult to trace the ducts above this level.

*Liver.*—Dog 11, which had lived 25 months from the time of the anastomosis to necropsy, had a well-advanced hobnail liver. Dog 13, which had lived six months after a Roux-Y anastomosis, had a somewhat firm, granular liver suggestive of early cirrhosis. In Dog 3, examined 21 months after choledochoduodenostomy, the surface of the liver was slightly granular, and the liver cut with increased resistance, suggesting fibrosis. In Dog 4 studied 24 months after choledochoduodenostomy the liver appeared blotchy, as yellowish-brown areas were scattered over the cut sur-

face. The livers of the remaining dogs showed no gross abnormalities. To recapitulate, only one dog had frank cirrhosis, and this was the only dog in which stricture had developed at the site of the biliary-intestinal anastomosis.

*Lampblack.*—Four of the dogs did not receive the lampblack and fat meal prior to necropsy. Two of 5 dogs to which the meal was given and which had choledochoduodenal stomas had no lampblack in their biliary systems (Fig. 5). One of the four dogs with loop choledochojejunal stomas given the meal did not have carbon particles in the biliary tree, but this dog had a biliary stricture. Five of the dogs which had Roux-Y anastomoses were given lampblack, and none of them had any

Fig. 5.—Lampblack oozing from the site of choledochoduodenal anastomosis.

lampblack in the bile ducts. However, in three of these dogs the carbon did ascend between 3 and 8 in. (8 and 20 cm.) up the isoperistaltic jejunal limbs.

*Lacteals.*—When the lampblack and fat meal was given before necropsy, the lacteals of the mesentery of the duodenum or jejunum in the dogs which had undergone choledochoduodenostomy and loop choledochojejunostomy were engorged with white chyle. By contrast, the lacteals of the mesentery of the isoperistaltic limbs of jejunum of the dogs with Roux-Y anastomoses had a much different appearance. The lacteals in these dogs were usually visible for only a short distance up the defunctionalized limb, but in two of the dogs the lacteals were visible for 8 in., exactly the same distance as the carbon particles had ascended within the bowel lumina. It appears, then, that the presence or absence of visible lacteals in a dog that has recently been fed is evidence of the extent to which the isoperistaltic limb of the Roux-Y anastomosis is defunctionalized (Figs. 6 and 7).

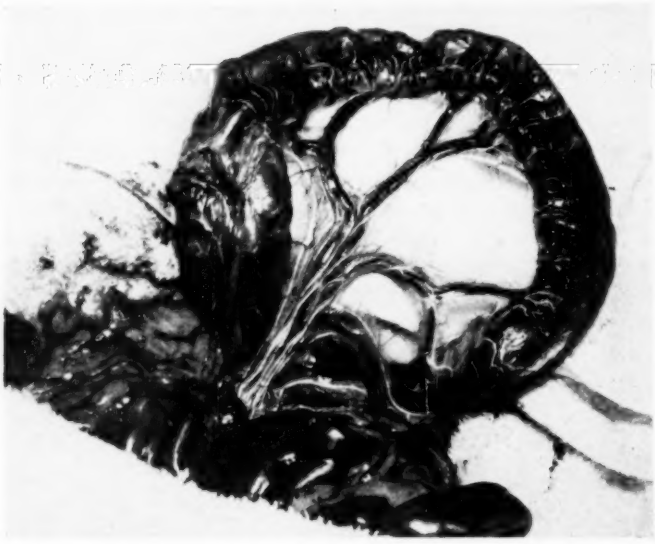

Fig. 6.—Functioning proximal jejunum showing engorged lacteals.

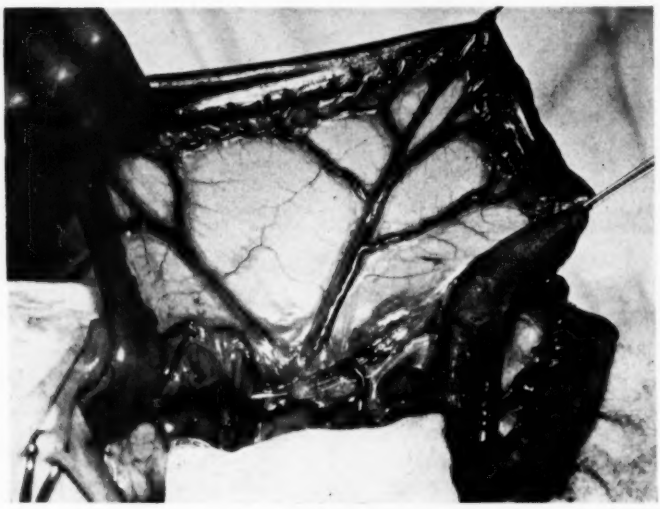

Fig. 7.—Defunctionalized Roux-Y limb in same dog as Figure 6, showing absence of visible lacteals.

*Histopathologic Study.*—Sections of the edge of the liver, intrahepatic bile duct, and tissue from the site of the anastomosis of all but one of the dogs were stained with hematoxylin and eosin and carefully studied for pathologic changes. Dog 16, with a Roux-Y type of anastomosis, was found dead in the kennel, and at necropsy the postmortem changes were too great to warrant histologic study.

Microscopic examination of tissue from the anastomosis and intrahepatic ducts was remarkable only in that there was very little evidence of inflammation in any of the sections. Even in the sections from the edge of the liver showing definite biliary cirrhosis the lining of the small bile ducts appeared normal.

The sections of the liver from Dog 11, which grossly was a hobnailed liver, showed the marked changes of biliary cirrhosis; namely, fibrosis of the portal canals, proliferation of bile ducts, round cell infiltration, and polymorphonuclear leucocytes.

TABLE 2.—*Microscopic Findings*

| Type of Anastomosis | Dog | Months of Anastomosis Functioning | Biliary Cirrhosis, Grade |
|---|---|---|---|
| Choledochoduodenostomy | 1 | 6 | 1 |
| | 2 | 12 | 0 |
| | 3 | 22 | 2 |
| | 4 | 25 | 3 |
| | 5 | 27 | —1 |
| | 6 | 30 | 0 |
| Choledochojejunostomy (loop) | 7 | 6 | —1 |
| | 8 | 9 | 1 |
| | 9 | 12 | —1 |
| | 10 | 17 | 2 |
| | 11 | 25 | 4 |
| Choledochojejunostomy (Roux-Y) | 12 | 5 | 2 |
| | 13 | 6 | 1 |
| | 14 | 7 | 1 |
| | 15 | 12 | 1 |
| | 16 | 12 | No sections |
| | 17 | 24 | —1 |
| | 18 | 27 | 0 |

The latter finding indicated acute inflammation. The liver cells in this animal showed slight-to-moderate degenerative changes. This was the most marked degree of biliary cirrhosis found in any of the sections of liver and was classified as biliary cirrhosis Grade 4. Cirrhosis exhibited in sections of livers of other dogs was graded accordingly, Grade 1 being the minimal amount of cirrhosis and Grade 4 the maximal. The results of microscopic study of sections from the edges of the livers and the number of months that the biliary-intestinal anastomosis had been present are shown in Table 2.

## BACTERIOLOGIC STUDIES

The specimens of gall-bladder bile taken during the first operations were all sterile but one, which showed a few Gram-positive rods, presumably owing to extraneous contamination. The bile was cultured on dextrose brain broth medium and on eosin-methylene blue agar, and, in addition, some specimens were cultured on rabbit blood agar plates. The failure to detect growth on these media after 7 to 10 days of incubation indicates that gall-bladder bile from normal healthy dogs is sterile.

The bile taken from the distended common ducts at the time of the biliary-intestinal anastomosis was also found to be sterile.

The bile removed from the common duct 6 to 24 months after the biliary-intestinal anastomosis was established was always infected with Escherichia coli and, in many cases, with a variety of Gram-positive rods and Gram-negative cocci.

## COMMENT

Roentgenographic studies indicate that an antiperistaltic limb of jejunum 18 in. (46 cm.) in length prevents regurgitation of barium into the intrahepatic bile ducts. It was of interest that the biliary reflux occurred more readily and barium was retained for a longer time in the bile ducts of dogs after loop choledochojejunostomy than after choledochoduodenostomy. Others [1] have found that an entero-enteric anastomosis between the limbs of the loop is of little or no value in preventing this reflux.

Estimations of serum bilirubin were of little value in determining hepatic damage in this study.

The most interesting gross finding at necropsy was the presence of hobnailed cirrhotic liver in the only dog that had a stricture at the site of the biliary-intestinal anastomosis. We interpret this as strong evidence that anastomotic stricture, and not intestinal-biliary reflux, was the main cause of serious damage to the liver.

The study of the distribution of the lampblack and the engorged lacteals at necropsy was of note mainly in the Roux-Y group. In 2 of these dogs the lampblack had regurgitated 8 in. up the isoperistaltic limb of jejunum, and the lacteals were engorged for a similar distance. These findings tend to indicate that an isoperistaltic or defunctionalized limb of jejunum would prevent reflex if it was more than 8 in. in length. Pearse, Redakovich, and Cogbill [1b] found reflux for a distance of 10 in. (25 cm.) and recommended the antiperistaltic limb of a Roux-Y type of anastomosis be made 12 in. (30 cm.) in length. Basso's [2] method of making an intussuscepted conical valve holds forth promise of shortening the necessary length of jejunal limb.

The histopathologic findings have been summarized in Table 2. All dogs of the group that had undergone loop choledochojejunostomy showed some evidence of biliary cirrhosis, the one with the anastomotic stricture having marked cirrhotic changes. Comparison of the Roux-Y dogs with the dogs which had undergone choledochoduodenostomy revealed no significant evidence that gross intestinal-biliary reflux caused increased damage to the liver.

The results of the numerous bacteriologic examinations indicate that bile of the gall-bladder and common duct tends to remain sterile for some time after the common duct is partially obstructed. After the biliary-intestinal anastomosis, bile of the common duct is always invaded by intestinal organisms.

1. (*a*) Cole, W. H.; Reynolds, J. T., and Ireneus, C., Jr.: Strictures of the Common Duct, Ann. Surg. **128**:332-347 (Sept.) 1948. (*b*) Pearse, H. E.; Radakovich, M., and Cogbill, C. L.: An Experimental Study of Antiperistaltic Jejunal Loops, ibid. **129**:57-64 (Jan.) 1949.

2. Basso, D. E.: The Efficacy and Applicability of an Intussuscepted Conical Valve in Preventing Regurgitation and Leakage of Intestinal Contents, Ann. Surg. **133**:477-485 (April) 1951.

SUMMARY

Partial obstruction of the common bile duct was produced in a series of dogs at the time of cholecystectomy. After an interval of 10 to 12 weeks the dilated common duct was exposed above the point of stricture, and a side-to-side anastomosis was performed between this portion of the duct and the upper part of the intestinal tract. In one group of dogs the duct was anastomosed to the duodenum, in another group to an upper loop of jejunum, and in a third group to a Roux-Y loop of jejunum. One dog from each of the three groups of dogs was killed under anesthesia 6 months after anastomosis was performed, and the other dogs of the group were killed in the same manner between 7 and 30 months after the anastomosis was made.

Stricture at the site of anastomosis and associated severe biliary cirrhosis occurred in one dog, a dog in which the common duct was anastomosed to a loop of jejunum. All other anastomoses were widely patent. Slight-to-moderate degrees of biliary cirrhosis were found in most dogs, although none had jaundice or significant bilirubinemia. Reflux of intestinal content into the biliary tract was demonstrated in dogs in which the common duct was anastomosed either to the duodenum or to a loop of the jejunum but could not be demonstrated in dogs in which the common duct was anastomosed to the proximal end of a Roux-Y loop of jejunum. On the other hand, the results obtained by the last type of anastomosis, in respect to nutritional state, general condition, and degree of biliary cirrhosis were no better than, if as good as, when the common duct was anastomosed to the intact jejunum or duodenum. Slightly, though perhaps not significantly, better results were obtained when the common duct was anastomosed to the duodenum than when it was anastomosed to a jejunal loop.

## DISCUSSION

DR. OTIS F. LAMSON, Seattle: Four years ago at the meeting of the Western Surgical Association I reported a new technique for doing a hepaticoduodenostomy. It was published in the *Archives of Surgery*, May, 1948.

The duodenum must be mobilized by incising the hepaticoduodenal ligament for a distance of 4 or 5 in. (10 or 13 cm.). A 3 in. (8 cm.) longitudinal incision is then made through the anterior wall of the duodenum. Care should be taken not to extend the incision too close to the stomach, so it will not interfere with pyloric control. The longitudinal incision in the duodenum can now be sutured transversely. This widens the duodenum about 3½ in. (9 cm.) and brings it into close contact with the common hepatic duct without tension. Anastomosis with the common hepatic duct is made over a catheter that is large enough to cause it to fit snugly at the site of the anastomosis. About 6 in. (15 cm.) of this catheter should extend into the left hepatic duct and about the same amount of the catheter into the duodenum. When the tube fits snugly at the site of the anastomosis, it usually takes from four to five months for it to loosen up sufficiently for the tube to pass into the bowel.

There is almost no likelihood that there would be a reflux of food or digestive juices into the hepatic duct because of the greatly enlarged duodenum. Peristalsis would naturally force the food and other contents into the natural channel, the duodenum.

DR. R. L. SANDERS, Memphis: The findings from the experiments conducted by Drs. Musgrove, Grindlay, and Karlson corroborate my opinion of choledochoduodenostomy as expressed in an article published in *Annals of Surgery* in 1946.

In view of the systemic and local disturbances associated with prolonged duct obstruction and the surgical problems which may present themselves as a consequence, the operation for overcoming the obstruction should be one which both is easily executed and offers the best

prospect of early, adequate, and permanent bile drainage. When conditions are proper, choledochoduodenostomy admirably fulfills these requirements. It is especially applicable to those cases in which the common duct is greatly enlarged incident to partial or total stricture of the outlet or to obstruction by a malignant growth. We have employed the procedure chiefly in the presence of a duct enlarged and distended with stones and sandy material, with the distal end small and difficult to dilate sufficiently to insure proper drainage. Even though the outlet can be fully dilated, the contracture may recur even years later, producing a repetition of the previous train of events and necessitating a second operation.

The first criterion of choledochoduodenostomy is a duct sufficiently large to permit a stoma of ample width to insure adequate and continuous drainage. Second, the portion of the duct above the obstruction must be long enough to allow one to make an anastomosis without tension, or one must be able to mobilize the duodenum extensively. If these criteria are observed, there will be little likelihood of subsequent stenosis of the stoma. After operation, bile empties into the intestinal tract at approximately the normal level, and intestinal function is soon restored. Intraductal pressure is equalized by the pressure in the intestinal tract, and additional damage to an already seriously impaired liver by increased intrahepatic pressure is avoided. In addition, the free drainage through the wide stoma serves to preclude reflux and ascending infection.

While the essayists' experiments have been made on animals, there seems to be no reason for hesitancy in performing choledochoduodenostomy on human subjects. To the present time, we have employed the procedure in more than 50 private cases, with, on the whole, excellent results. Bile drainage has remained free, and the patients have obtained remarkable relief of their symptoms. Signs of ascending infection have appeared in only a few patients, and even then to a mild degree. Our continued experience has further convinced us that choledochoduodenostomy is based upon sound physiologic principles. When the indications are met and the stoma is made sufficiently wide, the danger of reflux is negligible and one may expect a lastingly favorable outcome.

DR. ALFRED LARGE, Detroit: An experiment similar to some of those reported so interestingly by Dr. Musgrove has recently been done in our laboratory, and I should like to make some statements about the results in our dogs. At the first operation the common duct was doubly ligated and cut across, and then two weeks later it was anastomosed to the duodenum, care being taken to obtain careful mucosal approximation.

Nineteen of these dogs have been followed. Stricture developed in one dog, and the animal was discarded; the other 18 dogs had ducts that stayed wide open, and these animals were followed up to 18 months and then killed. Now, every one of these ducts was wide open and yet ascending cholangitis developed in every one of the animals. Several dogs had marked thickening of the ducts both within and without the liver, and there was marked thickening of the gall-bladder wall. Three of the dogs died, and pus was found in the extrahepatic ducts and in the liver. In five animals foul-smelling bile developed. All had some regurgitation and infection, and, most interestingly, in 10 of the animals concretions developed within the gall bladder. One of the 10 had an impaction in the cystic duct, and hydrops of the gall bladder developed.

Now, I am wondering why our results are different from those reported today. Perhaps our method of preparation of the animals may have been somewhat different, or some other factor not yet appreciated may have been at play. In any case, I am sure we will agree that the problem warrants additional study.

I wish to compliment Dr. Sanders on his excellent results in patients with strictures of the bile ducts; yet the results in this experiment of ours have been so striking that my colleagues and I hesitate to perform such an operation on patients as of this moment.

DR. CARLETON MATHEWSON, San Francisco: Dr. Sanders has emphasized the importance of a wide anastomosis. It is true that a large opening is less likely to result in secondary stricture for two reasons. In the first place, purely from a mechanical point of view, it is more difficult for a large opening to close than a small one. Secondly, and more important, I believe, is the fact that a large opening prevents retention of contaminated intestinal fluid in the biliary tree. Stricture usually occurs secondary to inflammation set up by retained intestinal contents within the biliary ducts. It is not uncommon to observe the regurgitation of barium given by mouth in

the normal biliary tract without clinical evidence of infection; however, cholangitis will result if a stricture of the common duct is present. This is probably caused by the retention of intestinal contents proximal to the stricture.

Secondary stricture of the common duct following repair has been common in our experience; however, we have yet to see stricture following pancreaticoduodenectomy when the common duct has been anastomosed to a defunctionalized loop of small bowel. These clinical observations would seem to substantiate the experimental observations of the authors of this excellent paper.

DR. J. E. MUSGROVE, Albuquerque, N. M.: I should like to mention two thoughts that come to mind regarding the Roux-Y type of biliary anastomosis. The first is the possibility of the development of a duodenal ulcer following the side-tracking of the alkaline bile into the upper jejunum. Dr. A. C. Whipple has recently reported such a case. I wish to put the second thought in the form of a question. Why did the dogs with the Roux-Y biliary-intestinal anastomosis not do as well as those with the choledochoduodenal anastomosis? In an attempt to answer this question I wish to suggest that the abnormal site of entrance of bile into the intestine in the Roux-Y dogs may play a part in producing this detrimental effect. This is a good problem for someone interested in experimental biliary surgery.

# ACUTE CHOLECYSTITIS, ITS PATHOGENESIS AND REPAIR

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AND
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CHAPEL HILL, N. C.

DESPITE the number of experimental and clinical studies directed toward an understanding of acute cholecystitis, there are many problems concerned with its etiology that remain unresolved.

The experimental approaches to the production of acute cholecystitis are numerous and vary according to the concept of disease. Initially investigators emphasized the role of infection and stasis, although clinical observations indicated that the morphologic change in the gall-bladder wall was not characteristic of the change provoked by bacterial infection and that stasis in the absence of obstruction produced no harm. Cultures of the gall-bladder contents as well as of the wall showed a relatively low incidence of positive results in early phases of acute cholecystitis.[1] The infrequency of the disease in children, its common association with stone, the infrequency of its association with suppurative disease involving the portal system, its relation to habitus, to obesity, to sex—these and many other clinical observations are not in keeping with the concept of infectious origin. It is apparent indeed that factors other than infection are of prime importance in the pathogenesis of this disease.

Mann [2] was the first to produce cholecystitis by chemical means, viz., the introduction of surgical solution of chlorinated soda (Dakin's solution) intravenously. Subsequent investigators, attempting to determine the role of substances somewhat more physiological in occurrence, studied the action of bile and pancreatic juice. The latter was invoked experimentally by Wolfer,[3] and subsequent investigations of Colp, Gerber, and Doubilet [4] confirmed the presence of the pancreatic enzymes, amylase and trypsin, in the gall bladder in three cases of acute cholecystitis in man.

From the Department of Surgery, State University of Iowa College of Medicine, Iowa City.

Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

1. Goldman, L.; Morgan, J. H., and Kay, J.: Acute Cholecystitis: Correlation of Bacteriology and Mortality, Gastroenterology **11**:318, 1948. Andrews, E., and Henry, L. D.: Bacteriology of Normal and Diseased Gallbladders, Arch. Int. Med. **56**:1171, 1935. Lester, D. J.: Acute Cholecystitis with Special Reference to the Occurrence of Jaundice, Surgery **21**:675, 1947.

2. Mann, F. C.: The Production by Chemical Means of a Specific Cholecystitis, Ann. Surg. **73**:54, 1921.

3. Wolfer, J. A.: The Role of Pancreatic Juice in the Production of Gallbladder Disease, Surg., Gynec. & Obst. **53**:433, 1931.

4. Colp, R.; Gerber, I. E., and Doubilet, H.: Acute Cholecystitis Associated with Pancreatic Reflux, Ann. Surg. **103**:67, 1936.

The exciting role of pancreatic juice was also demonstrated experimentally by Bisgard and Baker [5] and by Gatch, Battersby, and Wakim.[6] However, pancreatic juices have not assumed significant clinical importance although in instances they are capable of producing acute cholecystitis.

Andrews and his co-workers [7] were the first to suggest that cholecystitis could occur secondary to injury of the gall-bladder wall by the action of bile. Womack and Haffner [8] have demonstrated that evidence of bile or its components is frequently encountered upon microscopic study of the diseased human gall bladder. Womack and Bricker,[9] and later Gatch, Battersby, and Wakim,[6] were able to produce acute cholecystitis experimentally by the introduction of concentrated bile or bile salts within the gall bladder. It is to be noted that although their methods were uniformly successful, they were not physiological and necessitated employment of situations that did not occur either fortuitously or with disease in the human.

Although the role of obstruction of the cystic duct is apparently an important one in the pathogenesis of the disease, experimentally in most instances it results in a mild acute inflammatory process in the gall-bladder wall that rapidly subsides, with resulting hydrops. Occasionally such cystic duct obstruction is not followed by such minimal changes. Wilkie and Doubilet [10] noted that in a series of experiments in which the cystic duct of dogs was isolated and ligated, leaving the artery, veins, and lymphatics intact, "in the majority of the animals at the end of 24 hours the wall of the gall bladder was found to be inflamed or gangrenous on histologic section." The method of preparation of these animals was not disclosed. Also Cole, Novak, and Hughes [11] observed that chronic incomplete obstruction over a long period was capable of producing chronic cholecystitis morphologically similar to that seen in the human.

It occurred to us that a more physiological method of concentrating bile could be obtained by withholding food from an animal for 48 hours. From the few studies on the concentrating ability of gall bladder [12] and comparisons of concentrations of the various components of liver and gall bladder, it is evident that all biliary constituents may vary independently of one another. Aronsohn [7] has published the most

5. Bisgard, J. D., and Baker, C. P.: Studies Relating to the Pathogenesis of Cholecystitis. Cholelithiasis and Acute Pancreatitis, Ann. Surg. **112**:1005, 1940.

6. Gatch, W. D.; Battersby, J. S., and Wakim, W. G.: Nature and Treatment of Cholecystitis, J. A. M. A. **132**:119, 1946.

7. Aronsohn, H. G., and Andrews, E.: Experimental Cholecystitis, Surg., Gynec. & Obst. **66**:748, 1938.

8. Womack, N. A., and Haffner, H.: Cholesterolosis: Its Significance in the Badly Damaged Gallbladder, Tr. South. S. A. **55**:103, 1944.

9. Womack, N. A., and Bricker, E. M.: Pathogenesis of Cholecystitis, Arch. Surg. **44**:658, 1942.

10. Wilkie, A. L., and Doubilet, H.: Passage of Cholesterol Through the Mucosa of the Gallbladder, Arch. Surg. **26**:110, 1933.

11. Cole, W. H.; Novak, M. V., and Hughes, E. V.: Experimental Production of Chronic Cholecystitis by Obstructive Lesions of the Cystic Duct, Ann. Surg. **114**:682, 1941.

12. Rous, P., and McMaster, P. D.: The Concentrating Activity of the Gallbladder, J. Exper. Med. **34**:47, 1921.

complete studies in this regard, although methods of preparation of the dogs were not mentioned. In the animals studied by him the bile acids were noted to be 204.5 mg. per 100 cc. in liver bile and 719.5 mg. per 100 cc. in gall bladder bile. In a limited number of observations on dogs we have found that in the normal animal the gall-bladder bile five to seven hours after eating contained an average of 147 mg. of cholesterol and 4,983 mg. of cholic acids per 100 ml. If the animal fasted 48 hours, the concentration of cholesterol was 174.9 mg. per 100 cc. and cholic acids were 6,470 mg. per 100 cc. These concentrations are not so great as those which have been introduced experimentally to produce cholecystitis, viz., 5 to 10% solutions of bile salts.[13] It must be emphasized that of perhaps even more importance is the relative concentration of the various bile acids, since they vary considerably in their individual toxicity.

If, then, after bile had been concentrated within the gall bladder, the cystic duct were obstructed, a situation would exist which would fulfill the requisites for initiating acute cholecystitis, viz., (1) obstruction of the cystic duct, and (2) action of bile on the gall-bladder wall. Furthermore, this situation would be analogous to such a physiological process in the human with concentration of bile by the gall bladder and obstruction of the cystic duct by a calculus.

Accordingly, on the basis of the above analysis, the following experiments were carried out to substantiate this hypothesis.

## METHODS EMPLOYED

Thirty-three mongrel dogs were utilized. From all animals, food was withheld during the 48 hours preceding the experimental procedure. Under these circumstances the bile within the gall bladder is so concentrated that it is dark brown and somewhat viscid as contrasted with the clear golden yellow bile within the common duct.

Intravenous sodium pentobarbital anesthesia was employed and the following procedures were carried out:

1. Division and ligation of the cystic artery—4 dogs.
2. Separation of the gall bladder from the liver bed—2 dogs.
3. Division and ligation of the cystic duct—4 dogs.
4. Division and ligation of the cystic duct and artery—4 dogs.
5. Division and ligation of the cystic duct and artery with replacement of the bile within the gall bladder by isotonic sodium chloride solution—4 dogs.
6. Ligation and division of all components of the cystic pedicle, viz., duct, artery, vein, and lymphatics—15 dogs.

In every instance celiotomy was carried out 48 hours after the initial operation. Further observations were made at two, four, and eight weeks in different animals. None of the animals received chemotherapy.

In some of the initial observations, in order to follow the course and mechanism of healing in acute cholecystitis as produced by the method described, an area of the fundus of the gall bladder was excised for biopsy. In these instances subsequent healing at the site of biopsy was dependent upon the condition of the gall bladder. Consequently in those gall bladders that were gangrenous or involved by acute cholecystitis there was little restitution, and death usually occurred from perforation and bile peritonitis. Therefore, in subsequent cases, after the characteristics of acute gangrenous cholecystitis had been recognized grossly and confirmed by

13. Womack and Haffner.[8] Womack and Bricker.[9] Wilkie and Doubilet.[10]

microscopic examination, the gall bladder was allowed to remain intact and a gross diagnosis was made. At subsequent periods, i. e., two, four, and eight weeks, at the time of exploration a gross as well as a microscopic examination was made of the gall bladder.

## RESULTS

In Series 1, the cystic artery was ligated and divided in four dogs. At 48 hours the gall bladder was grossly normal in appearance and emptied readily on compression in each instance. A biopsy in one disclosed mild congestion of the subserosal vessels. These findings were similar to the observations of Cole, who carried out a similar procedure.[11]

In Series 2, the gall bladder was separated from the liver bed in two dogs. At 48 hours the gall bladder of each dog was of normal bluish-gray color. There were no adhesions to the surrounding viscera except to the liver. Biopsy disclosed edema and subserosal hemorrhage, but no evidence of necrosis.

In Series 3, the cystic duct was isolated from other constituents of the cystic pedicle and divided between ligatures in four dogs. At 48 hours the gall bladder was grossly normal in three instances. In the remaining dog the gall bladder was damaged as a result of artifact. Biopsy of the first two dogs disclosed in one a normal-appearing wall and in another edema of the wall, congestion and venous thrombosis (Fig. 1*A*).

In Series 4, the cystic duct and artery were individually ligated and divided in four dogs. At 48 hours, in three instances the entire gall bladder was gangrenous, thin-walled, and completely enclosed by liver and omentum (Fig. 1*B*). Contents of the gall bladder were under tension. In the fourth dog, the gall bladder was erythematous with considerable edema of the wall and localized areas of focal gangrene involving the fundus. The latter areas measured approximately 0.5 cm. in diameter. The omentum was adherent about the gall bladder in this instance.

In Series 5, in four dogs, the cystic duct was isolated, the gall bladder was aspirated and filled with 0.9% sterile saline solution via the cystic duct, without injury to the gall-bladder wall; then both the cystic duct and the artery were isolated and divided. At 48 hours the gall bladders were somewhat edematous but otherwise normal in appearance. There was no suggestion of focal or massive gangrene (Fig. 2*A*).

In Series 6, 15 dogs, all the contents of the cystic pedicle, viz., the cystic duct, artery, veins, and lymphatics were isolated en masse, ligated, and divided. In these dogs at 48 hours, five gall bladders were tense and grossly gangrenous and in most instances surrounded by a pericholecystic collection of fluid and walled from the free peritoneal cavity by omentum. One dog was dead at 40 hours, necropsy disclosing a gangrenous gall bladder, with perforation of the fundus resulting in bile peritonitis and death. In three instances, the gall bladder at 48 hours was edematous, erythematous, and surrounded by serosanguineous fluid. This condition grossly was considered to be acute cholecystitis. Subacute cholecystitis was noted in three additional animals, the findings being characterized by edema with mild to moderate erythema and a few adhesions to omentum and liver. In two instances the gall bladder appeared normal, both grossly and microscopically. Chronic cholecystitis with a thickened gray gall-bladder wall was observed in one case.

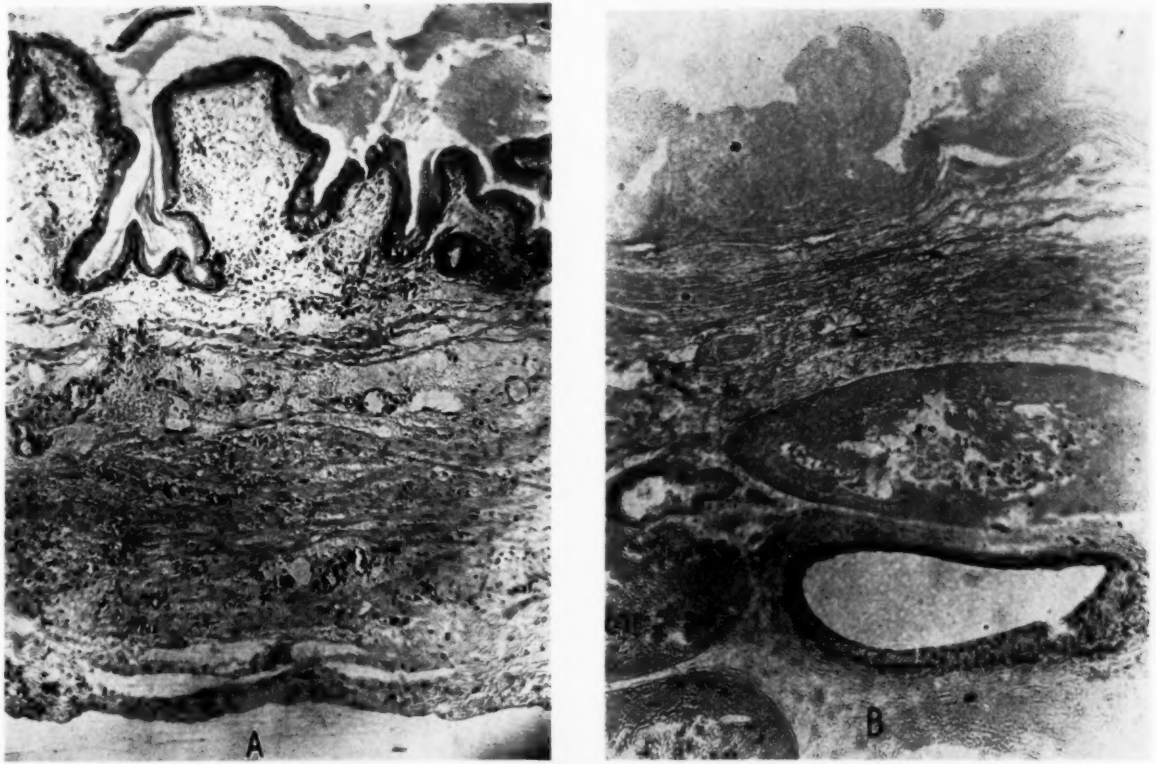


Fig. 1.—*A*, edema of gall-bladder wall, 48 hours after ligation of cystic duct. *B*, gangrene of entire gall-bladder wall, 48 hours after division and ligation of cystic duct and artery.

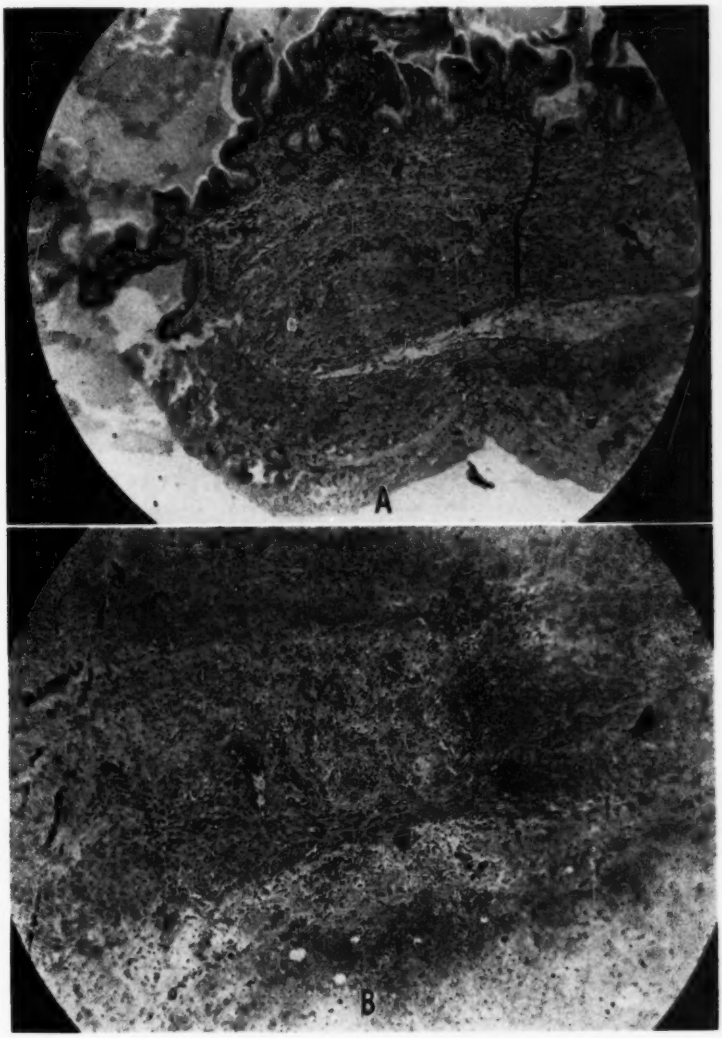


Fig. 2.—*A*, minimal inflammatory changes in gall-bladder wall, 48 hours after division and ligation of cystic duct and artery with replacement of contents of gall bladder with 0.9% sodium chloride solution. *B*, necrosis of muscularis four days after production of acute cholecystitis by ligation of cystic pedicle.

ANALYSIS OF FINDINGS

On the basis of these experimental observations, it would seem evident that the production of changes in the wall of the gall bladder that are analogous to those in cholecystitis in man are dependent upon the following factors:

1. Obstruction of the cystic duct.
2. Action of concentrated bile within the gall bladder.
3. Impairment of blood supply to the gall bladder.
4. Occasional secondary development of bacterial infection which would be superimposed on chemically damaged tissue.

Apparently the blood supply of the gall bladder is such that there is sufficient collateral circulation from the liver to supply its metabolic needs in the absence of the usual contribution of the cystic artery (experiments in Series 1). That the cystic artery itself is capable of maintaining an adequate blood supply to the gall bladder is demonstrated by the procedures carried out in Series 2. Under those circumstances in which the blood supply was decreased without obstruction to the cystic duct or imprisonment of concentrated bile, the reactions described as acute cholecystitis in Series 6 were not observed. Apparently the toxic action of the bile is potentiated by impairment of blood supply, even though this impairment in the absence of obstructed bile is insufficient to produce appreciable pathologic change as judged by gross and microscopic examination. In all the cases of acute or subacute cholecystitis the gall bladder was tense. Distention in any degree produces definite interference in intramural anastomotic channels and decrease in vascularity.

The role of infection in this process seems to be a secondary one, since there was little evidence of bacterial infection within the first few days and even at longer periods in many instances bacteria seemed to play a minimal role.

An analogous situation would seem to be present in cholecystitis in humans, when, following the lodgment of a calculus in the cystic duct with development of spasm, there follows localized edema, which impairs the venous and lymphatic drainage from the gall bladder if not its arterial blood supply. Furthermore, increase in the intraluminal tension contributes to the decrease in blood supply in the wall of the viscus.[14]

As interpreted from these experiments, the course of events in the pathogenesis of acute cholecystitis may be summarized as follows. Obstruction of the cystic duct is followed by a destructive action of bile on the gall-bladder wall, the severity and speed of this reaction probably being influenced by the concentration of the bile and state of the gall-bladder circulation. Interference with venous as well as lymphatic return may occur at the site of obstruction and there may be some decrease in blood supply due to spasm of the cystic artery. That these circulatory changes alone are not responsible for the reactions observed is evidenced by the fact that alteration in blood supply produced by division of the cystic artery does not seem to affect the gall bladder in an adverse manner. Collateral circulation from the liver is apparently sufficient to maintain adequate blood supply under such circumstances.

Histologically the early reaction in the gall-bladder wall is characterized primarily by alteration in the subserosa, viz., subserosal edema, dilatation of subserosal

14. Noer, R. J., and Deer, J. W.: Effect of Distention on Intestinal Revascularization, Arch. Surg. **59**:542, 1949.

lymphatics, and venous congestion with diapedesis of red cells. The changes in the muscularis are similar but less conspicuous, and there may be little alteration in the mucosa. Many lymphocytes and a few polymorphonuclear leucocytes may be found infiltrated throughout the wall. The process is progressive and may be followed by necrosis of tissue within 48 hours of onset. In many instances the necrosis is focal, occurring most commonly in the region of the fundus of the gall bladder (Fig. 2*B*).

In a small percentage of cases, perforation through an area of necrosis occurs, with escape of gall-bladder contents. However, the initial reaction is such that, owing to the fibrinous exudate on the surface of the gall bladder, there is adherence to adjacent viscera and omentum. This is a frequent but often overlooked occurrence in the human. Thereupon an incipient perforation is immediately walled off.

The role of infection in this process seems dependent upon (1) the presence of bacteria within the gall bladder or the lymphatics of the gall bladder, (2) the virulence of the bacteria, and (3) the severity of the chemical damage. Although infection occurs in the course of events, it is not a necessary integral part of the process.

Following the initial reaction as observed at 48 hours, attempts at restitution may be noted. Only one animal died of spontaneous perforation of the gall bladder and bile peritonitis. This can probably be explained by the immediate adherence of omentum and neighboring viscera to the gall bladder, thereby effectively walling off any possible perforation through the focal areas of gangrene. We have been impressed with how well observed areas of gangrene at the end of 48 hours become sequestered by adhesions to surrounding viscera and then replaced by scar tissue and by mucosal epithelium. In general, healing is characterized by subsiding edema, the presence of macrophages engulfing lipid, necrotic material, and progressive fibroplasia (Fig. 3). Depending upon the amount of necrosis and injury to gall-bladder epithelium and blood supply, the process may remain latent for weeks with evidence of acute and chronic inflammation and active fibroplasia even at the end of that time. This is true in the human also.

In those animals in which acute cholecystitis was noted at 48 hours, at two weeks there was still evidence of acute and chronic inflammation with the presence of macrophages. Subserosal edema was conspicuous, and early evidence of fibroplasia was noted. Healing areas in muscle previously involved by focal necrosis were present (Fig. 4). Epithelial regeneration was also noted (Fig. 5).

At four weeks fibroplasia was even more prominent and acuteness of the inflammatory reaction was less pronounced. Xanthomatous reaction can be noted, which may represent phagocytosis of lipid (Fig. 3). Unless the initial injury was particularly severe, epithelial regeneration is usually complete although low in character because of the scarring in the lamina propria.

Examination at eight weeks disclosed in many instances a small thick-walled gall bladder containing dark rubbery mucus. Microscopically the epithelium was flat and was seen lying on a base that was almost beyond recognition owing to the severe fibroplasia present in the lamina propria, muscularis, and subserosa (Fig. 6).

In one dog in which the initial reaction observed was only subacute, a "hydrops" was present at eight weeks.

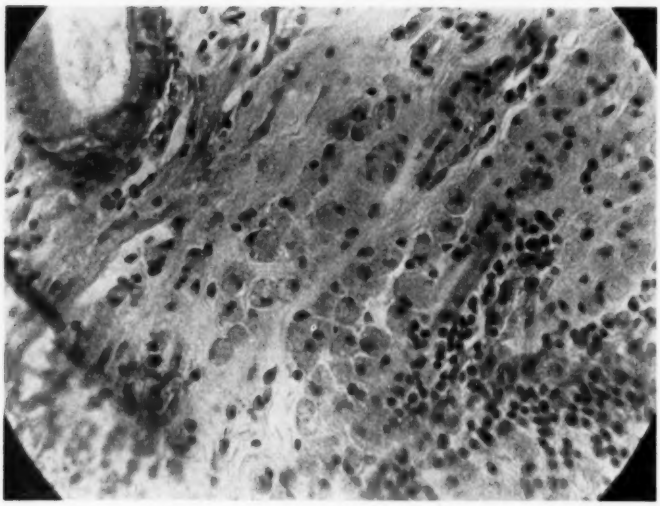

Fig. 3.—Phagocytes containing lipid immediately beneath mucosa, four weeks after production of acute cholecystitis by ligation of cystic pedicle.

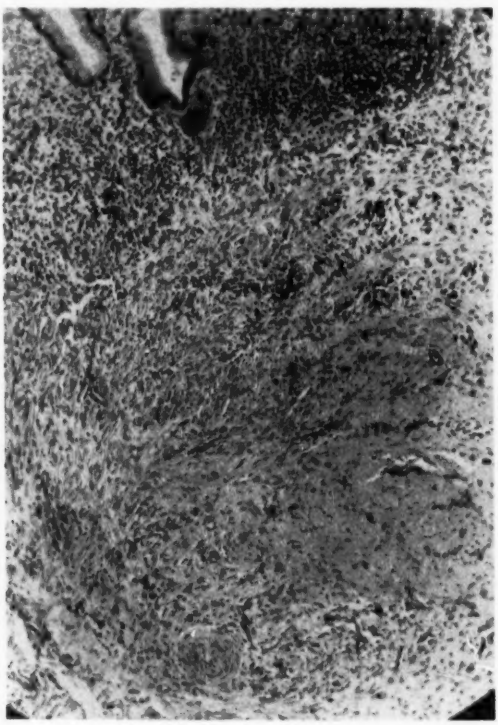

Fig. 4.—Replacement of muscularis by cicatrix, two weeks after production of acute cholecystitis by ligation of cystic pedicle.

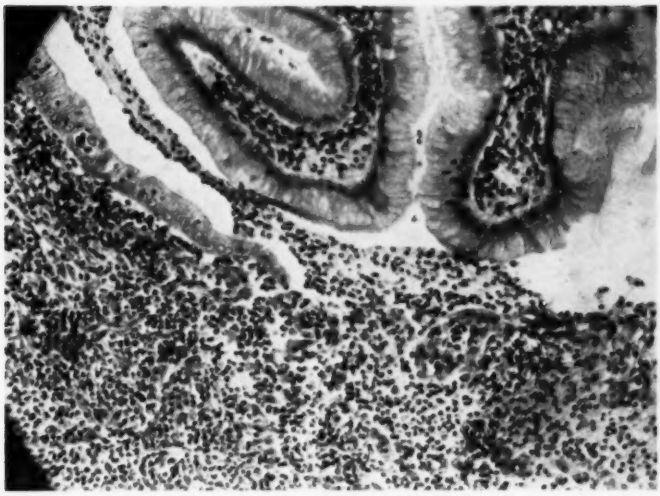

Fig. 5.—Regenerating epithelium, two weeks after production of subacute cholecystitis by ligation of cystic pedicle.

Fig. 6.—Flattened epithelium with replacement of lamina propria and muscularis by cicatrix, eight weeks after production of gangrenous cholecystitis by ligation of cystic pedicle.

## COMMENT

The material and findings presented correlate well with previous work demonstrating the etiologic role of bile in acute obstructive cholecystitis. This relatively physiological concentration of bile utilized in the present experiments reemphasizes its role. The experimental situation in the dog might be compared to an analogous condition of cystic duct obstruction in the human. In fact Glenn [15] has called attention to the incidence of acute cholecystitis postoperatively in unrelated diseases. Seemingly, this would simulate the experimental situation since these patients have had little food by mouth during the preceding 24 to 96 hours.

There are several facts which are not adequately explained, however. Many patients experience repeated attacks of cholecystitis, and at such times the gall bladder is rendered functionless, if the concentration of iodoalphionic acid (priodox®) is used as a criterion. Yet despite this loss of concentrating ability, there is no assurance against subsequent attacks, which may occur with increasing frequency. In such situations perhaps the concentration of bile is adequate for damage, or other factors which we have not considered play a part. One explanation is that one obstructive attack may so injure the circulation of the gallbladder wall that it is rendered more susceptible to subsequent injury by mere obstruction of the cystic duct even though the bile is not greatly concentrated. Another consideration in the human is that restitution probably occurs to a greater degree than in the experimental animal. Thus, despite numerous and severe attacks of acute cholecystitis, the findings at operation, unless it is performed soon after an acute attack, are those of chronic cholecystitis, and only infrequently is the gall bladder as severely damaged and replaced by cicatrix as in the experiments cited above.

The clinical significance of these observations and their application to the evaluation and treatment of acute cholecystitis have been reported elsewhere.[16]

## SUMMARY

A method is presented whereby acute cholecystitis in dogs can be produced, utilizing physiological concentrations of bile. The production and course of the disease are described. The significance of these findings is discussed.

15. Glenn, F. C.: Acute Cholecystitis Following Surgical Treatment of Unrelated Disease, Ann. Surg. **126**:411, 1947.

16. Thomas, C. G., Jr., and Womack, N. A.: Symposium on Recent Advances in Surgery: Treatment of Acute Cholecystitis, S. Clin. North America **29**:1445, 1949.

# CONSTRUCTION OF FOOD POUCH FROM SEGMENT OF JEJUNUM AS SUBSTITUTE FOR STOMACH IN TOTAL GASTRECTOMY

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CONNER,[1] in 1884, probably performed the first total gastrectomy. Recently, total gastrectomy has been more frequently done for carcinoma of the stomach, especially for those lesions in the midportion of the stomach or higher. Lahey [2] now advocates radical total gastrectomy for all operable carcinomas of the stomach and reports a decided increase in the three-year survival rate. The technic has been standardized; the management has become more physiologic, and the mortality rate has steadily decreased.

Certain disadvantages, related to nutritional deficiency, weight loss, anemia, and reflux esophagitis, are associated with total gastrectomy. Various modifications of the standard procedure of anastomosing the small bowel to the esophagus have been suggested to diminish some of these problems. Hoffman,[3] in 1922, made a small stoma between the two limbs of the jejunal loop. This afforded a partial bypass of the duodenal contents and reduced the incidence of reflux esophagitis. Orr,[4] in 1947, divided the jejunum a number of inches below the ligament of Treitz and anastomosed the esophagus to the side of the distal jejunum and the proximal jejunum to the side of the distal segment. This was after the manner of the Roux-Y principle and was for the purpose of preventing reflux esophagitis. Steinberg,[5] in 1950, made a wide stoma between the two limbs of the jejunum and described it as a pantaloon anastomosis. This affords a wide bypass of duodenal contents and a large capacity for food intake. Recently, Lee [6] has substituted the right colon for

From the Surgical Service Research Hospital, Research Clinic, and Hunt Surgical Group.

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1. Conner, P. S.: Report of a Case of Complete Resection of the Stomach, M. News **45**:587, 1884.

2. Lahey, F. H.: Total Gastrectomy for All Patients with Operable Cancer Stomach, Surg., Gynec. & Obst. **90**:246, 1950.

3. Hoffman, V.: Eine Methode des "plastischen Magenersatzes," Zentralbl. Chir. **49**:1477, 1922.

4. Orr, T. G.: A Modified Technic for Total Gastrectomy, Arch. Surg. **54**:279 (March) 1947.

5. Steinberg, M. E.: Prevention of Some Post-Gastrectomy Difficulties by New Gastrectomy Technic (Pantaloon Anastomosis), J. Internat. Coll. Surgeons **14**:194, 1950.

6. Lee, C. M., Jr.: Transposition of a Colon Segment as a Gastric Reservoir After Total Gastrectomy, Surg., Gynec. & Obst. **92**:456, 1951.

the resected stomach and anastomosed the terminal ileum to the esophagus and the colon portion to the duodenum and then restored intestinal continuity by an ileocolostomy. The ileocecal valve probably would prevent reflux of contents into the esophagus, and the large cecum would afford a reservoir for food intake.

We attempt to prevent reflux into the esophagus by a Roux-Y procedure and to form a food pouch by folding a few inches of the distal jejunum in a side-to-side fashion and making a stoma between the full length of these approximated structures.

## TECHNIQUE OF OPERATIONS

After the stomach, great omentum, and spleen have been removed and the duodenal stump closed, the jejunum is divided between clamps about 12 to 14 in. (30 to 35 cm.) below the ligament of Treitz. The distal limb of the jejunum is brought up anterior to the colon, and the end is doubled back upon itself in a side-to-side manner for about 6 in. (15 cm.). The sides of these loops are sutured together, and an anastomosis with a full-length stoma is made, with

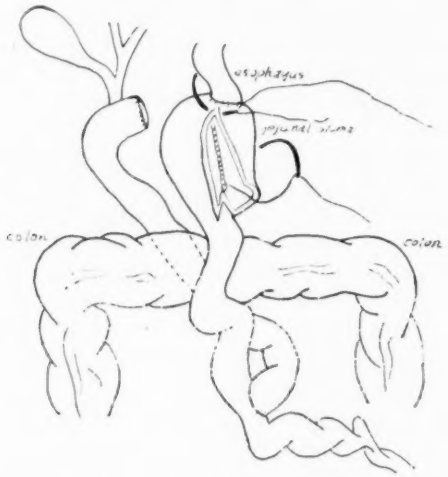


Fig. 1.—Conversion of jejunal loop into food pouch. Duodenal contents are diverted by end-to-side anastomosis of jejunum.

the transected end of the jejunum incorporated in the anastomosis as shown in Figures 1 and 2. This forms a large pouch, which is then anastomosed to the esophagus by interrupted surgical silk suture and continuous 00 chromic surgical gut.

The anastomosed pouch is further supported by sutures to the diaphragm and surrounding peritoneum to relieve tension.

The proximal jejunum is then anastomosed to the side of the distal jejunum, well below the pouch. Figure 2 shows the closed pouch anastomosed to the esophagus and the end-to-side anastomosis of jejunum to jejunum.

A Levin tube, which has been in the esophagus, is passed down through the pouch well into the jejunum below the Roux-Y anastomosis and is useful as a means of administering fluid and feedings in the postoperative period.

We have formed a food pouch similar to the one described above by using an isolated loop of jejunum with its mesenteric attachment maintained and have anastomosed the pouch to the esophagus and the end of the jejunum to the duodenum.

The jejunum from which the isolated segment was removed is united by an end-to-end anastomosis. This has not yet been done on the living patient but has been performed in the autopsy room. It appears to be a feasible way of substituting for the stomach a food pouch made from the jejunum that more closely approximates a normal anatomic relationship (Fig. 3).

## REPORT OF CASES

CASE 1.—T. De L., aged 53, was admitted to Research Hospital on Feb. 18, 1950, complaining of epigastric distress and fullness on eating, difficulty in swallowing, and loss in weight of 15 lb. (7 kg.). X-ray examination revealed a large filling defect involving the fundus and the entire lesser curvature.

The patient was prepared for gastric surgery, and on March 2, a total gastrectomy, with removal of spleen and greater omentum and 3 cm. of esophagus, was done through a thoraco-abdominal approach. A food pouch was constructed from a loop of jejunum, as previously described (Fig. 4). A Levin tube was passed into the jejunum beyond the pouch. Tube feedings

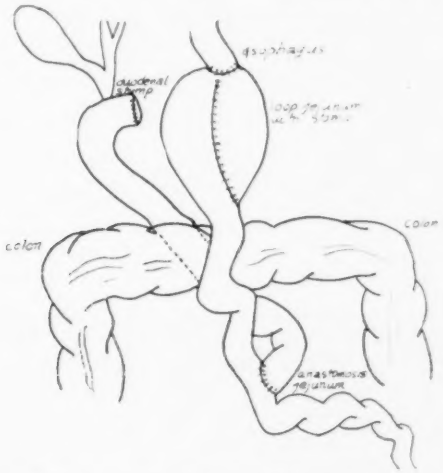


Fig. 2.—Food pouch formed from jejunal loop with end-to-side anastomosis of jejunum.

were started on the 3d day, and the tube was removed on the 10th day and feedings started by mouth. The patient had an easy postoperative course and was dismissed from the hospital on March 13.

The pathologist reported a Grade 3 adenocarcinoma of the stomach involving the lower portion of the esophagus and the upper half of the stomach, with metastases to all nodes. The patient gained 9 lb. (4 kg.) after operation, was holding his former job, and was eating three normal meals daily. On some special occasion recently, the patient drank two bottle of beer, after which he ate a T-bone steak, French fried potatoes, a tossed salad, and a dessert. This condition of apparent good health continued without distress or any evidence of an esophagitis until September, 1951. Abdominal distention and a progressive anuria then gradually developed. He died Nov. 11, 1951, from uremia and colon obstruction due to peritoneal pelvic metastasis. Autopsy revealed an uninvolved jejunal pouch, a patent esophageal stoma and abdominal pelvic metastasis.

CASE 2.—W. R., aged 75, was sent to Research Hospital on Sept. 12, 1950, with a diagnosis of carcinoma of the stomach. X-ray examination showed a large lesion involving the fundus and the lesser curvature and extending up to the cardia.

On Sept. 16, after adequate preparation, a total gastrectomy with removal of the spleen and greater omentum was done through an upper left rectus approach. The glands around the celiac axis were removed, and a jejunal food pouch was constructed (Fig. 5). Tube feedings were started on the third day, and on the ninth day food was given by mouth. The patient had a satisfactory postoperative course and was dismissed from the hospital on Nov. 18, after a convalescent stay of three weeks.

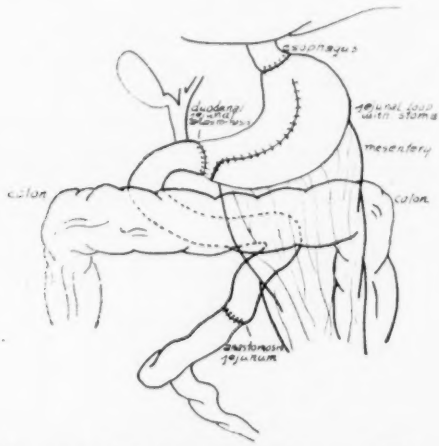


Fig. 3.—Proposed formation of food pouch from jejunum with anastomosis to esophagus and duodenum. Small bowel is united by end-to-end anastomosis.

Fig. 4 (Case 1).—Roentgenogram demonstrating size of food pouch.

Pathological report was Grade 4 carcinoma involving the entire stomach and adjacent glands.

On Nov. 10, 1951 (13 months after surgery) the patient reported that he was eating three normal meals a day with nourishment in midafternoon and was feeling fine. He was about as active as before surgery and recently took part in his state fair. He has had no epigastric distress or regurgitation. When last heard from, on Nov. 26, 1951, he was doing well.

CASE 3.—Mrs. M. M., aged 57, was admitted to Research Hospital on March 4, 1951, with a diagnosis of cancer of the stomach. She had much gastric distress and had lost 25 lb. (11 kg.) in weight. X-ray examination revealed an extensive lesion of the pars media and the lesser curvature of the stomach.

At operation, on March 7, an extensive cancer of the stomach with involvement of the transverse colon mesentery and the colon by continuity was found. A total gastrectomy with removal of the spleen, adjacent nodes, and the segment of involved transverse colon and its mesentery was done (Fig. 6). A jejunal food pouch, as described, was constructed and an end-to-end anastomosis of the transverse colon was accomplished. Tube feedings were started on the third day. Because of an alarming distention of the cecum, a cecostomy was done on the third day. The patient had a very smooth postoperative course and was dismissed on April 1.

Fig. 5 (Case 2).—Roentgenogram showing size of food pouch three weeks after operation.

The pathologist reported a Grade 3 adenocarcinoma of the stomach involving the proximal half.

Four months later, on Aug. 4, she was readmitted for closure of the cecostomy opening. She was eating three meals a day with midmorning and afternoon feedings and had gained 4 lb. (1.8 kg.) Her main complaint was that the cecostomy acted every time she ate. After closure of the cecostomy opening on Aug. 8, this disquieting occurrence was eliminated. There had been no regurgitation or evidence of esophagitis. In November, 1951, her condition was reported as satisfactory.

CASE 4.—Mrs. K., aged 74, entered Research Hospital on June 3, 1951. X-ray examination revealed a large polypoid lesion involving the greater and the lesser curvature in the pars media of the stomach.

On June 11, through a transverse incision, a total gastrectomy with removal of greater omentum and spleen was done and a jejunal food pouch was constructed. Tube feedings were begun on the 4th day and oral feedings on the 10th day. The patient had an uneventful postoperative course and was dismissed on July 1.

The pathology report was that the tumor was a reticulum-cell sarcoma involving most of the stomach and invading the gastrocolic and gastrohepatic omenta.

The patient was seen on Nov. 17, and found to be feeling well; roentgenograms were taken. There was no gain of weight. X-ray examination showed a large functioning food pouch. The patient eats three substantial meals a day, with protein milk in midmorning and afternoon.

Case 5.—A. R., aged 78, was admitted to Research Hospital on June 13, 1951, because of three gastric hemorrhages in the past two months. The radiologist reported a large filling defect

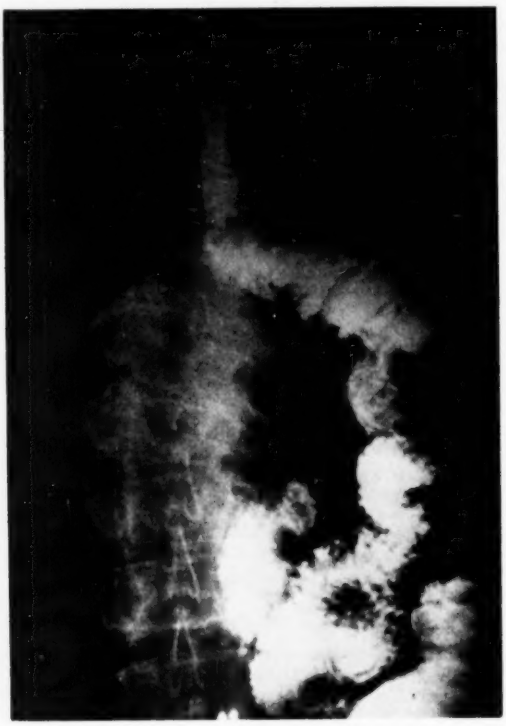

Fig. 6 (Case 3).—Emptying function and apparent capacity of food pouch. This patient had a simultaneous resection of the transverse colon.

in the pars media of the stomach. After several transfusions the patient was operated on on June 21, at which time a total gastrectomy with removal of greater omentum and a portion of transverse colon mesentery was done. A jejunal food pouch was constructed.

Tube feedings were started on the third day and oral feedings on the seventh day. The patient was dismissed on July 5, 1951, in good condition.

The pathologist reported a large Grade 3 carcinoma of the pars media with ulceration and penetration of the anterior wall of the stomach.

Four months from the date of operation, the patient had gained 3 lb. (1.3 kg.), had no discomfort and was eating fairly normal meals daily. When last seen in this office on Nov. 26, 1951, he was doing well.

CASE 6.—S. T., a 65-year-old Negro man, was admitted to Wheatley Hospital on June 6, 1951, with a large carcinoma involving the upper half of the stomach. On July 13, total gastrectomy with construction of a jejunal food pouch was done by Dr. W. W. Cummins, of our group. A Levin tube was passed down into the jejunum; tube feedings were given for six days, and then oral feedings were started. The convalescence and postoperative course were without incident, and patient was discharged on the ninth postoperative day.

The pathologist reported an extensive grade 3 carcinoma involving the fundus, cardia, and lesser curvature of the stomach, with involvment of one adjacent lymph node.

On last report this patient was taking three fairly substantial meals a day with nourishment in midmorning and midafternoon.

CASE 7.—Miss E. G., a white female school teacher, aged 65, was admitted to Research Hospital Oct. 17, 1951, with the chief complaint of epigastric pain and dyspepsia with loss of appetite over a period of six months. There had been no vomiting and no black stools. There had been a weight loss of 18 lb. (8 kg.) in the past six months. Her hemoglobin level was 67%. She was given two 500 cc. transfusions. Roentgenogram showed a large ulcerated area on the lesser curvature of the stomach. On Oct. 22, a total gastrectomy with splenectomy and resection of all available nodes around the celiac axis was done by W. W. Cummins, of our group. A food pouch of jejunum was constructed in the manner described above and the Levin tube brought down the distal loop for purposes of feeding and administering fluids. At the time of operation no metastases were present in the liver that could be found on gross examination.

The pathologist reported a large carcinoma of the stomach involving a small portion of the lower esophagus.

The postoperative course was uneventful until the sixth postoperative day, at which time the Levin tube slipped up and was removed. After this incident, the patient began to regurgitate intestinal contents. Thin barium swallows passed immediately through the esophagojejunal anastomoses but progressed very slowly after passage through the food pouch. The radiologist believed that the obstruction was due to spasm or incomplete obstruction, and a waiting course was followed until Nov. 5. At that time, since the patient continued to vomit on occasions, it was decided that a true obstruction of the small bowel existed. The old incision was reopened, and an adhesive constricting band involving the lower small bowel was found and released.

The constricted area did not expand readily; so an enteroenteroanastomosis was done. The patient reacted well and was taking food and was up and about on the second postoperative day. Except for slight drainage from the incision, the patient had an uneventful recovery and was discharged from the hospital Nov. 15, 1951.

## COMMENT

The described technique has been used by us in seven consecutive cases without mortality or undue morbidity. In each case a Levin tube was passed into the jejunum well below the Roux-Y anastomosis for feeding purposes and was left in place an average of nine days. In none of the cases was there evidence of a leak at the site of anastomoses. None of these patients have complained of reflux esophagitis, and all have taken progressively more food with the passage of time with corresponding slight gain in weight. One patient postoperatively had distention of the proximal colon after an associated transverse colon resection. Cecostomy was done the opening subsequently being closed. In one patient small bowel obstruction developed; it was surgically relieved.

We do not believe that any of these patients have been cured, because of the extent of the lesion in each case. We present the technique with the belief that it provides an adequate pouch for food intake, lessens requirements for frequent feedings, provides facilities for a balanced diet, diverts the duodenal contents, and alleviates the incidence of reflux esophagitis.

The esophagus is so vulnerable to bile and pancreatic juice that we believe the Roux-Y procedure should be employed in any type of operation in which the stomach is entirely removed. We do not believe that the terminolateral anastomosis of esophagus to jejunum, even with a wide enteroenterostoma, diverts all the bile and pancreatic secretion as well as does the procedure described by Orr or the described procedure of pouch formation and Roux-Y diversion of duodenal contents.

## DISCUSSION

DR. WILLIS D. GATCH, Indianapolis: I am discussing Dr. Hunt's paper with mixed emotions, for I am not yet convinced that total gastrectomy is the best treatment for carcinoma of the stomach. I do not believe that what Koenig said about 60 years ago has been disproved; namely, that the kinds of carcinoma of the stomach which we can cure have been small, hard, movable lumps near the pylorus. The death rate still remains at about 95%. Of course, anything one can do to improve this situation is commendable, but I am convinced that in a very large number of cases the disease is already incurable and unrecognizable by any known method of diagnosis by the time the patient realizes that something is the matter.

I want to congratulate Dr. Hunt, however, on his very ingenious method of making a stomach pouch after total gastrectomy. The fact that here we have two papers on this subject indicates that total gastrectomy alone leaves much to be desired. The patients I have observed have led a far from happy existence, and it seems to me that Dr. Hunt's operation would have helped them.

DR. CLAUDE J. HUNT, Kansas City, Mo.: These operations for the removal of the entire stomach are done only as a palliative procedure, and I agree with Dr. Gatch that the incidence of cure is very, very remote; but if we can add a few months of comfort to the lives of these unfortunate people, as we try to do for people with other kinds of cancer, we are doing something worth while for them. If we can obviate some of the undesirable features that are associated with the classic total gastrectomy, I think we have also accomplished something.

With our technique we are able to make a food pouch for these patients and to eliminate reflux esophagitis that is so often a cause of distress. We are unable to state how the segment of jejunum that replaces the stomach would be in the living subject. We have found it an easily performed procedure in the autopsy room. I think it is just as feasible as the one advocated by Dr. Lee, in which he transplants the right colon so that it takes the place of the removed stomach. I think it would be safe to assume that the innervation is somewhat impaired when a transplant of this nature is substituted for the stomach. Here the transplant is made of a segment of the jejunum that is in close approximation and of a structure more adapted to nutritional intake. The result probably would be more successful than if we transplanted a segment of the transverse colon or the right colon to the esophagus and the duodenum. These procedures should be thought about. Some experiments should be made with animals, and if successful they would add another method of making a food pouch for the patient who must undergo total gastrectomy.

# USE OF THORACICOABDOMINAL INCISION FOR UPPER ABDOMINAL NEOPLASMS

JOHN M. BEAL, M.D.
AND
WILLIAM P. LONGMIRE Jr., M.D.
LOS ANGELES

REMOVAL of neoplasms of the upper abdomen frequently requires extirpation of multiple organs. Although most lesions of the region can be adequately attacked through a direct abdominal incision, certain bulky neoplasms present problems in removal because of their size and the involvement of more than one structure. The thoracicoabdominal incision appears to be well suited for the surgical approach to such extensive lesions because it provides wide exposure for upper abdominal procedures and therefore renders resection of multiple visceral structures in this area more satisfactory. The purpose of this paper is to describe the use of the thoracicoabdominal incision for approaching large neoplasms arising in the upper abdomen and to outline a planned attack which facilitates the evaluation of operability and block resection of multiple organs in the upper peritoneal cavity. This report is based on experiences with 11 patients on whom the thoracicoabdominal incision was used in removing neoplasms which involved the excision of more than one organ.

## OPERATIVE PROCEDURE

After the induction of anesthesia, the patient's position is arranged so that the transverse axis of the body is at about a 30 degree angle to that of the table. The left side is elevated. The skin of the lower thorax and abdomen is prepared and draped for surgery. An oblique abdominal incision is made from the lateral margin of the right rectus muscle to a point approximately opposite the seventh left intercostal space. When the peritoneal cavity has been entered, an estimate of the size and extent of the lesion can be made. If exploration discloses hepatic metastases or peritoneal implants, either the procedure can be discontinued or, possibly, a palliative procedure can be accomplished. After the biopsy the abdominal incision can be closed. However, if this examination suggests that resection is feasible, the incision is extended into the seventh intercostal space by division of the costal margin (Fig. 1*A*). Resection of 2 or 3 cm. of the costal cartilage at the site of the transection facilitates closure. The diaphragm is incised toward the esophageal hiatus.

During division of the diaphragm, the lower lobe of the left lung is carefully retracted and a rib-spreading retractor inserted. This retractor is gradually extended during the incision of the diaphragm.

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Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

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In the case of neoplasms involving the cardia of the stomach, the esophagus is circumscribed, and a few centimeters of diaphragm is left attached to it. Mobilization of the upper abdominal viscera is now begun by incising the lateral reflection of the posterior parietal peritoneum from the esophageal hiatus to the inferior pole of the kidney (Fig. 1*B*). By retracting the spleen medially, the tail of the pancreas is readily mobilized and a relatively avascular plane is entered. The retropancreatic dissection may be rather easily continued up to a point where the superior mesenteric artery and vein can be visualized (Fig. 1*C*). In some of the large neoplastic masses involving the structures of the abdomen above the transverse mesocolon, operability may be determined by whether or not these two vessels are involved. Also an excellent opportunity is

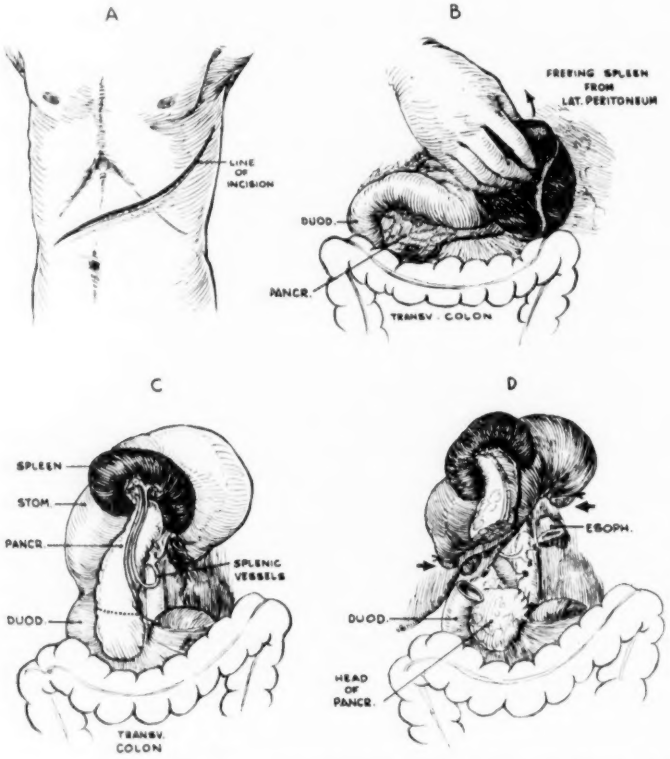


Fig. 1.—*A*, incision used in the thoracicoabdominal approach to upper abdominal neoplasm. *B*, initial step in mobilization of the upper abdominal viscera. *C*, retroperitoneal approach to determine operability. This is accomplished without division of important structures. *D*, block resection of stomach, spleen, and distal pancreas has been completed.

afforded to inspect the nodes along the aorta. If the superior mesenteric vessels are involved to a degree that precludes removal of the neoplasm, the reflected tissue can be replaced into its normal position and the incision closed. However, if excision of the tumor is feasible, the operation is continued and the omentum removed from the transverse colon. If either the transverse colon or the transverse mesocolon is involved, the portion of the colon between the hepatic and splenic flexures is removed. If the colon does not need to be sacrificed, the peritoneum from the upper surface of the transverse colon is reflected and removed. In most cases the duodenum may now be divided about 5 cm. distal to the pyloric ring. The pancreas can be divided between clamps or between silk sutures passed around the neck of the gland. Little

difficulty has been experienced in dissecting the pancreas from the mesenteric vessels because of the exposure afforded by the incision. The splenic vein is now transected. The periportal lymphatics are dissected, leaving the common duct, portal vein, and hepatic artery exposed. The gastrohepatic ligament is incised at the margin of the liver and reflected medially. By tracing the hepatic artery cephalad, injury to this vessel is avoided. After the division of the splenic and left gastric arteries, the tumor mass is retracted upward over the superior margin of the incision (Fig. 1*D*). Its remaining attachment is to the esophagus. If the nature of the lesion has not required removal of the entire stomach, the stomach can be transected at an appropriate site, possibly without division of the left gastric artery. The continuity of the gastrointestinal tract can be restored by gastrojejunostomy at this point. If total gastrectomy is required, a suitable lengh of esophagus is mobilized and an esophagojejunostomy is accomplished without the application of clamps to the esophagus.

The majority of patients have had an end-to-side esophagojejunostomy supplemented with a distal jejunojejunostomy. One patient had an end-to-end esophagojejunostomy with a Roux-Y limb approximately 18 in. (46 cm.) long.

More recently the continuity of the gastrointestinal tract has been restored after total gastrectomy by interposing a segment of jejunum about 18 in. long between

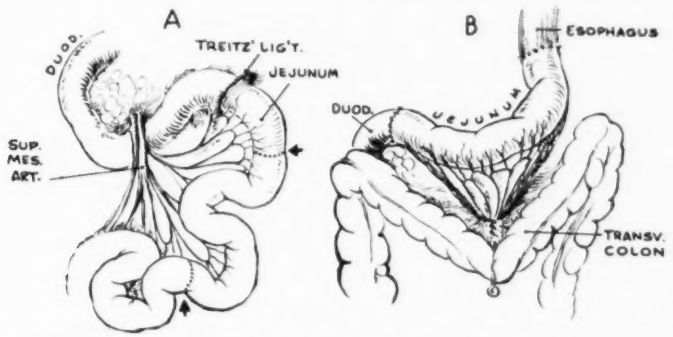


Fig. 2.—Diagrammatic representation of mobilization of jejunum for interposition between esophagus and duodenum following total gastrectomy.

the esophagus and duodenum with open end-to-end anastomosis (Fig. 2). This procedure will be reported elsewhere in more detail. After restoration of the continuity of the gastrointestinal tract, the incision is closed. The chest is usually closed without drainage, although a catheter in the posterior axillary line through a stab incision in the eighth or ninth intercostal space may occasionally be necessary. When the pancreas is transected, a drain is brought through the abdominal wall from the left upper posterior peritoneal space.

## CLINICAL EXPERIENCES

The 11 patients in this series have all been operated upon since May, 1950. Thus not enough time has elapsed to warrant evaluation of eventual survival. Ten patients were male, and one was female. Their ages ranged from 26 to 72 years. Two patients were operated upon at St. John's Hospital, Santa Monica, Calif. The remaining ones were from the Surgical Service, Wadsworth General Hospital, Veterans Administration Center, Los Angeles. Seven patients had carcinoma of the stomach. One patient had lymphosarcoma of the stomach; one had leiomyosar-

*Analysis of Cases*

| Patient | Sex | Age, Yr. | Diagnosis | Operation | Complications | Follow-Up |
|---|---|---|---|---|---|---|
| R. K. | F | 60 | Recurrent adenoma of transverse colon (resection 11/15/49) | Partial gastrectomy, left nephrectomy, partial pancreatectomy, splenectomy, resection of transverse colon 12/20/50 | None | Exploratory laparotomy 6/28/51; hepatic metastases |
| J. M | M | 59 | Leiomyosarcoma of stomach with perforation and abscess | Total gastrectomy, splenectomy, partial pancreatectomy, transverse colectomy and partial hepatectomy; esophagoduodenostomy 12/5/50 | Anastomotic leak; resection of anastomosis and esophagojejunostomy 12/27/50 | Alive and well 10/30/51 |
| J. E. | M | 26 | Carcinoma of stomach | Total gastrectomy, splenectomy, left adrenalectomy, partial pancreatectomy, cholecystectomy, esophagojejunostomy 5/31/50 | None | Died in 3 wk.; carcinomatosis |
| J. Z. | M | 56 | Carcinoma of stomach | Total gastrectomy, splenectomy, esophagojejunostomy 7/28/50 | ..... | Died 8/21/50; cerebral vascular accident |
| L. K. | M | 32 | Lymphosarcoma of jejunum | Partial gastrectomy, splenectomy, resection transverse colon, resection jejunum 11/7/50 | None | Exploratory laparotomy and biopsy 1/18/51; died 4/2/51; strangulation of small bowel |
| J. E | M | 66 | Carcinoma of cardia stomach | Palliative esophagogastrostomy and splenectomy (hepatic metastases 10/30/50) | Esophagopleural-cutaneous fistula | Died 4/7/51; carcinomatosis |
| J. V. | M | 59 | Carcinoma of stomach | Total gastrectomy, splenectomy, resection transverse colon, esophagojejunostomy 11/20/50 | None | Died 7/15/51; carcinoma |
| M. H. | M | 72 | Lymphosarcoma of stomach | Total gastrectomy, splenectomy, partial pancreatectomy, resection transverse colon, esophagojejunostomy 1/8/51 | ..... | Died 1/12/51; cause? |
| J. L. | M | 44 | Carcinoma of stomach | Total gastrectomy, splenectomy, partial pancreatectomy, esophagojejunostomy (Roux-Y) 6/12/51 | None | Alive and well |
| T. E. | M | 61 | Carcinoma of gastric cardia | Total gastrectomy, splenectomy, partial pancreatectomy, "jejunal stomach" 6/16/51 | None | Alive and well |
| L. N. | M | 47 | Carcinoma of stomach | Total gastrectomy, splenectomy, partial pancreatectomy, "jejunal stomach" 7/10/51 | None | Alive and well |

coma of the stomach; one had lymphosarcoma of the jejunum, and the sole female patient had an adenocarcinoma of the transverse colon which had recurred approximately 11 months after a previous resection elsewhere. Total gastrectomy was performed in eight instances. In each operation part or all of some other abdominal organ was removed with the stomach. The postoperative course of two patients was complicated by a leak at the esophageal anastomosis. In one case the original esophagoduodenostomy was dismantled and an end-to-side esophagojejunostomy performed. The other patient had been subjected to a palliative esophagogastrectomy for carcinoma of the gastric cardia. At the time of operation the pleural cavity was drained by a catheter. Although the anastomotic defect was small, drainage persisted until the patient died, six months later. It appeared that the leak was the result of persistent carcinoma at the suture line.

There were three deaths in the immediate postoperative period. One patient, a 26-year-old white man, died from disseminated hematogenous carcinomatosis three weeks after total gastrectomy, splenectomy, adrenalectomy, partial pancreatectomy, and cholecystectomy were performed for gastric carcinoma. A second patient, who had a total gastrectomy and splenectomy for carcinoma of the stomach, died suddenly of a massive cerebral vascular accident 24 days after operation. The 72-year-old white man who died four days after total gastrectomy, splenectomy, partial pancreatectomy, and resection of the transverse colon for lymphosarcoma of the stomach had no specific cause of death which could be determined at autopsy. There was no remaining demonstrable neoplasm, and all anastomoses were intact.

The patient with recurrent adenocarcinoma of the colon now has evidence of liver metastasis. Two others have died of carcinoma and one of unrecognized strangulated small bowel due to intraperitoneal adhesions. Four patients are alive and show no evidence of recurrence, but the longest follow-up period is 11 months.

## COMMENT

Since Kirschner [1] applied the combined thoracicoabdominal incision for approaching the lower esophagus its use has been prescribed for splenectomy,[2] nephrectomy,[3] total gastrectomy,[4] and resection of the lower esophagus.[5] There have been numerous variations in the basic incision, but there has been general unanimity of opinion in regard to the excellent exposure afforded. Since blood for transfusions has become more available, better anesthesia developed, and potent antibiotics derived, the surgical attack upon massive abdominal neoplasms has been rendered more practical. In general, satisfactory removal of such lesions involves a block resection of the organs involved and removal of the available lymphatics without transection

1. Kirschner, M.: Ein neues Verfahren der Oesophagoplastik, Arch. klin. Chir. **114**:606, 1920.

2. Carter, N. B.: The Combined Thoracoabdominal Approach with Particular Reference to Its Employment in Splenectomy, Surg., Gynec. & Obst. **84**:1019, 1947.

3. Harper, F. R.: Thoracoabdominal Approach to the Upper Abdomen, Surg., Gynec. & Obst. **84**:331, 1947.

4. Kremen, A. J.: A Combined Abdominothoracic Incision Particularly Adapted for Use in Total Gastrectomy and Esophagogastrostomy, Surgery **24**:605, 1948.

5. Garlock, J. H.: Combined Abdominothoracic Approach for Carcinoma of the Cardia and Lower Esophagus, Surg., Gynec. & Obst. **83**:737, 1946. Humphreys, G. H., II: An Approach to Resections of the Esophagus and Gastric Cardia, Ann. Surg. **124**:288, 1946.

of neoplasm tissue. This is followed by restoration of the gastrointestinal tract in a continuity as anatomical as possible.

The method of approach described in this report was undertaken for two reasons: First, the operability of the lesion could be definitely determined without division of any important structures that might require removal or reconstruction. Second, the approach afforded excellent exposure in block removal of massive upper abdominal neoplasms and aided in the dissection of structures on both sides of the upper abdomen and in the retroperitoneal space.

The feasibility of multiple organ resection in abdominal operations has been illustrated by the reports of Brunschwig,[6] who reported 14 cases of advanced carcinoma of the stomach in which removal of the body of the pancreas and the spleen was included with total gastrectomy. More recently Allison and Borrie [7] advised that carcinoma of the gastric cardia be treated surgically by total gastrectomy, splenectomy, and resection of the pancreas and retroperitoneal tissue and nodes as far as the neck of the pancreas. Their premise is based on the anatomical description of the distribution of lymphatics in the upper abdominal contents which was described by Jamieson and Dobson in 1907.[8] The finding of sub- and/or suprapancreatic lymph nodes involved by carcinoma further supported their contention. A similar report has more recently been presented by McNeer and associates [9] and by Harvey and others.[10]

Thus there appears to be evidence that resection of multiple organs not only is practical but also is justified on pathological and anatomical grounds. It would appear that neoplasms other than carcinoma could be similarly attacked. The approach to such lesions described in this paper is a logical one.

## SUMMARY

The advantage of the thoracicoabdominal incision for resection of neoplasms arising in the upper abdomen is illustrated by its use in 11 cases.

The technique permits an extraperitoneal exploration and inspection of the celiac and aortic lymph nodes before the division of any important structures. The more adequate exposure gained by the application of this incision facilitates an extensive regional resection.

Eight patients in this group were subjected to total gastrectomy with removal of other organs. The importance of removing the distal two-thirds of the pancreas when gastrectomy is performed for carcinoma of the stomach is emphasized.

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6. Brunschwig, A.: Pancreato-Total Gastrectomy and Splenectomy for Advanced Carcinoma of the Stomach, Cancer **1**:427, 1948.

7. Allison P. R., and Borrie, J.: The Treatment of Malignant Obstruction of the Cardia, Brit. J. Surg. **37**:1, 1949.

8. Jamieson, J. K., and Dobson, J. F.: Lectures on the Lymphatic System of the Stomach, Lancet **1**:1061, 1907.

9. McNeer, G.; Sunderland, D. A.; McInnes, G.; Vandenberg, H. J., and Lawrence, W. J.: A More Thorough Operation for Gastric Cancer, Cancer **4**:957, 1951.

10. Harvey, H. D.; Titherington, J. B.; Stout, A. P., and St. John, F. B.: Gastric Carcinoma: Experience from 1916 to 1949 and Present Concepts, Cancer **4**:717, 1951.

## DISCUSSION

DR. STANLEY MAXEINER, Minneapolis: I have been using this incision for a fairly long time. I have a patient with carcinoma of the stomach on whom I operated six years ago. I resected the lower end of the esophagus and the upper two-thirds of the stomach and all of the lesser curvature but left a sufficient amount of the greater curvature so that I was able to bring it up and tubulate it to the esophagus. The patient was a man who ordinarily, perhaps, would have had an anastomosis between the esophagus and the jejunum, but I avoided that and obtained a much more physiologic condition. This patient eats normal meals three times daily. He is the chief cabinet maker for a large department store in Minneapolis, and has not, I believe, missed a day from work in six years.

In several instances I have followed a procedure which Dr. Judd described before this society about two years ago, that of anastomosing the duodenum to the cut-off end of the esophagus after total gastrectomy. It seems interesting that within six months after hearing Dr. Judd, I went back to Minneapolis and performed three such operations. The patients have all survived without mortality. One of them was in the office this last week. She has been a year and a half without any loss of weight. I knew at the time that I did the surgery that it was a palliative procedure for advanced carcinoma. The patient eats regularly, lives a normal life, and does not have any substitute for the stomach.

I think that an anastomosis between the duodenum and the esophagus by liberating the intestine close to the liver and rotating the entire duodenum is very frequently possible without any tension on either the esophagus or the duodenum. I believe this has been done in our Veterans' Hospital, with satisfaction. I think the mortality is very definitely to be considered, as we are dealing with conditions that hold out so little hope for the future. I don't want to throw any cold water on anybody's very wonderful work, such as has been done in the transplantation of the colon to replace a totally removed stomach, but I should like to call attention to an article in Theodore Kocher's textbook, which was written in 1914, in which substitution of the transverse colon for a totally removed colon is discussed.

# ARTERIAL BLOOD SUPPLY OF HUMAN STOMACH

JOHN REID BROWN, M.D.
AND
JOHN WM. DERR, M.D.
DETROIT

THE ARTERIAL blood supply of the normal human stomach and its usual variations are well known. Anatomical studies of injected cadaver specimens as diagrammatically shown in Figure 1 are comparable to those available in standard textbooks on the subject, and from clinical experience it has long been postulated that the supply is exceptionally rich. Few, if any, studies, however, have been undertaken to evaluate critically this blood supply by the more accurate method of injection and clearing, and it therefore seemed worth while to attempt to demon-

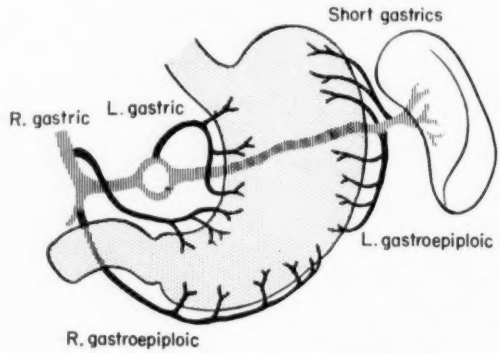


Fig. 1.—Normal arteries of the human stomach.

strate the intramural anastomotic system and to determine further the relative role played by each of the four major arteries in the vascular supply of the human stomach.

Studies of the blood supply of the small intestine by Noer and co-workers,[1] using survival experiments and injection techniques in the dog, demonstrated that there was a close correlation between the length of devascularized loop which the

Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

1. Noer, R. J., and Derr, J. W.: Revascularization Following Experimental Mesenteric Vascular Occlusion, Arch. Surg. **58**:576-588 (May) 1949. Noer, R. J.; Derr, J. W., and Johnston, C. G.: The Circulation of the Small Intestine: An Evaluation of its Revascularizing Potential, Ann. Surg. **130**:608-621 (Oct.) 1949.

animal would survive in life and that which could be filled by injection. Therefore it was felt justifiable, in spite of its limitations, to use this approach for a study of the vascularization of the human stomach in freshly removed autopsy specimens.

## METHOD

The specimens for study were removed at autopsy as soon after death as possible (varying from two to six hours) and included the greater portion of viscera supplied by the celiac axis. One of the four major vessels to the stomach was then selected for injection, and, its distribution

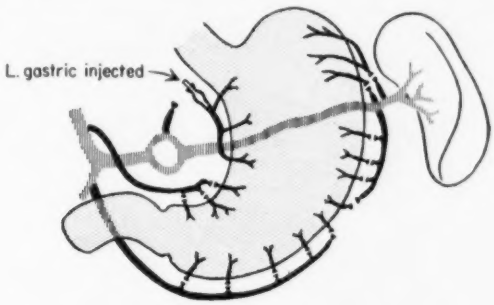


Fig. 2.—Injection of the left gastric artery.

Fig. 3.—Injected specimen of left gastric artery.

being left intact, the remainder of the vessels to the stomach were ligated and divided close to the stomach wall. A cannula was then inserted into the artery and another cannula into its accompanying vein. By means of a multiple-injection constant-pressure apparatus which had been developed for similar work on the small intestine, bovine plasma was first injected to flush the vessels and to identify any additional vessels to be ligated. Then red liquid latex or India ink diluted in bovine plasma was injected into the selected artery under a pressure of approximately 100 to 120 mm. of mercury. After injection of the vascular tree was felt to be complete, the specimen was immersed in 5% acetic acid to fix the latex. The specimens were then prepared for study and photography by using a modified Spalteholz technique, consisting of fixing the

specimen in 10% formalin, washing in water, dehydrating in dioxane and clearing in methyl-salicylate. A total of 20 specimens were utilized, with five injections being done through each major extragastric artery.

## RESULTS

In all instances injection of a major artery (right or left gastric or right or left gastroepiploic) after ligation and division of all other vessels at their point of

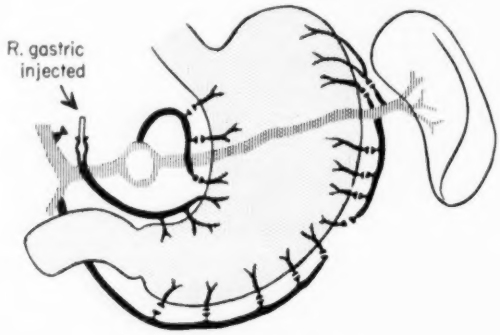


Fig. 4.—Injection of right gastric artery.

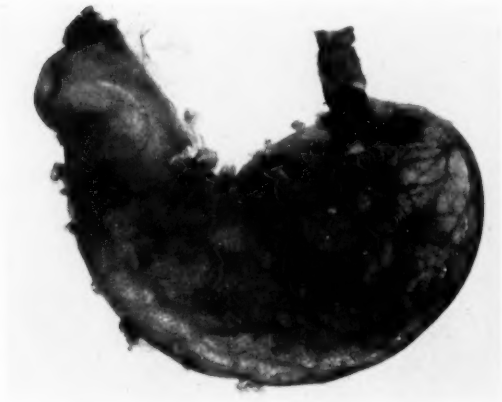

Fig. 5.—Injected specimen of right gastric artery.

entrance into the stomach wall resulted in a remarkably quick and complete filling of the arteries of the entire stomach wall through the intramural anastomotic plexus.

1. *Left Gastric Artery.*—Injection of this vessel (Fig. 2) resulted in a rapid spread of the injected medium from the lesser curvature side toward the antrum and cardia, with the greater curvature portions of the fundus, antrum, and cardia being the last to fill (Fig. 3).

2. *Right Gastric Artery.*—In this instance (Fig. 4) the vessels of the antrum filled rapidly, from the lesser to greater curvature portions. As the intramural

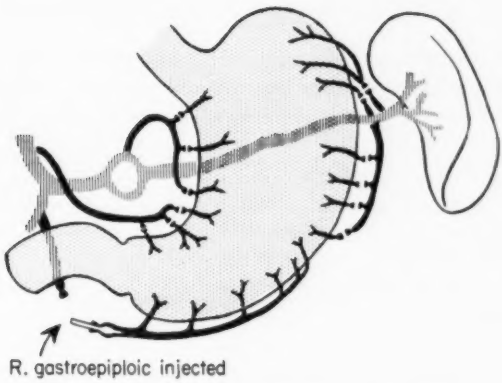


Fig. 6.—Injection of right gastroepiploic artery.

Fig. 7.—Injected specimen of right gastroepiploic artery.

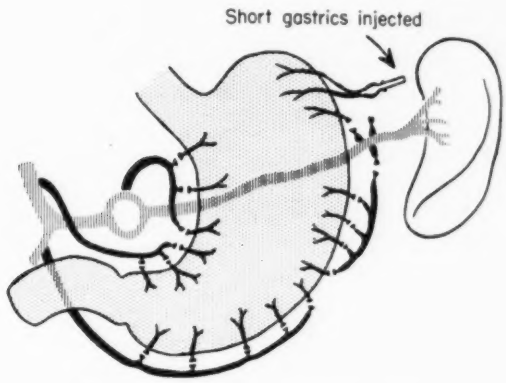


Fig. 8.—Injection of short gastric artery.

vessels filled, the medium also was seen to enter the distribution area of the left gastric artery from the lesser curvature side and then to spread quickly to the fundus and cardia, with the vessels of the greater curvature portion of these areas being the last to fill (Fig. 5).

3. *Right Gastroepiploic Artery.*—Injection of this vessel (Fig. 6) results in almost immediate filling of the vessels of the antrum on the greater curvature aspect of the stomach. The injected medium quickly fills the lesser curvature vessels, spreading upward to fill those of the fundus and cardia, with the greater curvature portion of the cardia being the last to fill (Fig. 7).

4. *Left Gastroepiploic Artery.*—Injection of this vessel (Fig. 8), or even one of the vasa brevia, showed filling of the greater curvature vessels of the fundus and cardia almost simultaneously; from them the medium spread to the lesser curvature

Fig. 9.—Injected specimen of short gastric artery.

and thence to the antrum filling the greater and lesser curvature vessels with about equal rapidity (Fig. 9).

Because of the opacity of the stomach wall, the path of the injected medium is somewhat difficult to trace, but in general the findings as outlined above are those consistently noted and are what one might expect to obtain. After the stomach specimens were cleared, the degree of vascular filling was even more pronounced. In all instances the earlier the specimen was utilized after death, the better were the results obtained. The only unsatisfactory specimens were those obtained in excess of six hours following death.

## COMMENT

It has long been postulated that the arterial supply of the stomach is exceptionally abundant, but pathways of this rich supply have not hitherto been demonstrated.

The results that have been obtained clearly demonstrate the importance of the intramural anastomotic system in the arterial supply of the stomach. While it must

be assumed that certain limitations exist in any attempt to apply clinically the results obtained from studies such as this, nevertheless inferences may be drawn which are worth while.

The demonstrated rich intramural blood supply would imply that one intact major artery is adequate to supply the stomach with arterial blood even though all other arteries are ligated. The margin of safety in gastric operations involving mobilization of the stomach with ligation of major extramural vessels is probably as great as, or even greater than, has been believed, and this fact should lend security in those instances in which such procedures are necessary.

Control of gastric hemorrhage by ligation of major extramural arteries of the stomach was at one time accepted by many surgeons and is still held by some. The results of these studies serve to lend greater weight to the futility of such a procedure, for there are such rich intramural anastomoses that it would seem that ligation of one, two, or even three major extramural vessels, so long as one is left intact, could not materially change the blood supply to a given part of the stomach which may be the site of hemorrhage.

Injection of any one of the four major extramural arteries to the stomach will completely fill the intramural plexus with the injection medium, and even though the filling is somewhat more rapid through some vessels than others, it is important that essentially an equal result is obtained from any vessel chosen.

## SUMMARY AND CONCLUSIONS

Complete filling of all the intramural vessels of the stomach in the human autopsy specimen may be obtained by injection of any one of the four major arteries with all other extramural vessels ligated.

The importance of the intramural arterial anastomotic system of the stomach has thus been demonstrated.

The clinical application of this study is discussed.

## DISCUSSION

DR. RUDOLF NOER, Detroit: I am not in any sense responsible for this work, which was done entirely by Dr. Brown and Dr. Derr. I have, however, followed it with a great deal of interest because it is closely related to the work that we did a few years ago on the small intestine.

There appears to be a tendency in considering anastomotic mechanisms to think chiefly in terms of the extragastric and extraintestinal vessels and to underemphasize the relative added importance of the intrinsic vessels which lie within the intestinal wall and within the wall of the stomach. This has been a very interesting demonstration, and for all of us it can be useful in its application to the field of gastric anastomoses. To me the most interesting thing is the rather complete filling after injection of the short gastric artery. I think that all of us have felt that any one of the four chief vessels to the stomach would adequately serve the entire organ, but I think that most of us did not think that this would also hold for one short gastric artery alone.

# CLINICAL AND PATHOLOGICAL REVIEW OF THE NODULAR THYROID

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AND
HARWELL DAVIS Jr., M.D.
EVANSTON, ILL.

A REVIEW of this problem, in a small general hospital, is of value because of its variance with many published reports.[1] Two different groups of patients are considered. The thyroids of 155 patients were investigated because of the presence of a "single nodule," observed clinically. These patients were otherwise unselected. Also studied are *27* patients with cancer of the thyroid who have been followed for periods varying from six months to 33 years. The primary operation in the latter group was not necessarily performed by us. Concurrent diagnosis on the tissue of each patient was made by more than one pathologist. All the cancers showed blood-vessel, lymphatic, or capsular invasion, or some combination.

At present the proper histopathologic categorization of cancer of the thyroid is difficult if not impossible because of the multiplicity of classifications now extant. They are the results of an attempt to render prognosis from histopathology alone.[2] It has been our experience that, excluding the bizarre carcinomas and sarcomas, the histologic picture does not correlate with survival of the patient. At our hospital only three necropsies have been performed for cancer of the thyroid since 1939. All these patients had a bizarre type of cancer.

The significance of blood-vessel invasion in the diagnosis of cancer of the thyroid should be reemphasized. By this we mean the demonstration of gross blood-vessel invasion as described by Graham, and not the microscopic picture often interpreted

Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

From the departments of Surgery and Pathology, the Evanston Hospital Association and Northwestern University Medical School.

1. (*a*) Cole, W. H.; Majorakis, J. D., and Slaughter, D. P.: Incidence of Carcinoma of the Thyroid in Nodular Goiter, J. Clin. Endocrinol. **9**:1007, 1949. (*b*) Cope, O.; Dobyns, B. M.; Hamlin, E., Jr., and Hopkirk, J.: What Thyroid Nodules Are to Be Feared? J. Clin. Endocrinol. **9**:1012, 1949. (*c*) Horn, R. C., Jr.; Welty, R. F.; Brooks, F. P.; Rhoads, J. E., and Pendergrass, E. P.: Carcinoma of the Thyroid, Ann. Surg. **126**:140, 1947. (*d*) Jaffe, R. H.: Variation in Weight of Thyroid Gland and Frequency of Its Abnormal Enlargement in Region of Chicago, Arch. Path. **10**:887, 1930. (*e*) Lahey, F. H., and Hare, H. F.: Malignancy in Adenomas of the Thyroid, J. A. M. A. **145**:689, 1951. (*f*) Rogers, W. F., Jr.; Asper, S. P., and Williams, R. H.: Clinical Significance of Malignant Neoplasms of the Thyroid Gland, New England J. Med. **237**:569, 1947.

2. Horn and others,[1c] Clute, H. M., and Warren, S.: The Prognosis of Thyroid Cancer, Surg., Gynec. & Obst. **60**:861, 1935.

as such.[3] While the gross demonstration of tumor within blood vessel is certainly diagnostic, the microscopic finding is often misinterpreted. This is because the thyroid, like most endocrine glands, is abundantly supplied with blood vessels and

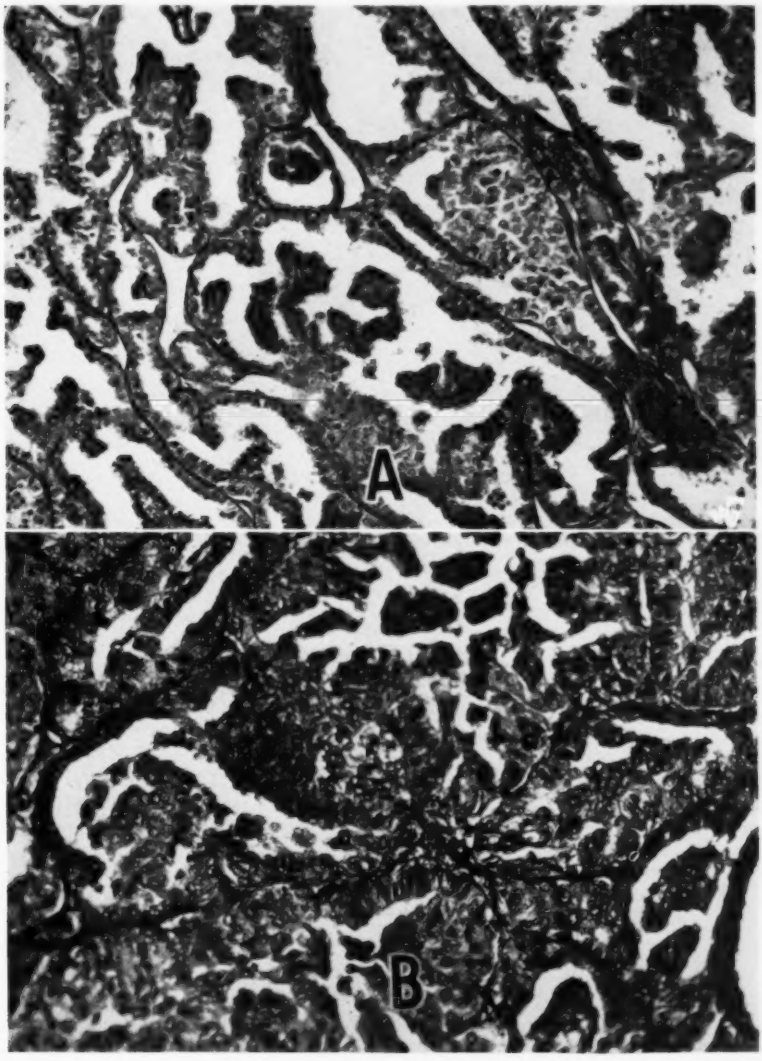


Fig. 1.—*A*, papillary tumor, primary; × 200. *B*, papillary metastatic focus reproducing structure of primary tumor; × 200.

3. Graham, A.: Malignant Epithelial Tumors on the Thyroid with Special Reference to Invasion of Blood Vessels, Surg., Gynec. & Obst. **39**:781, 1924; Malignant Tumors of the Thyroid: Epithelial Types, Ann. Surg. **82**:30, 1925.

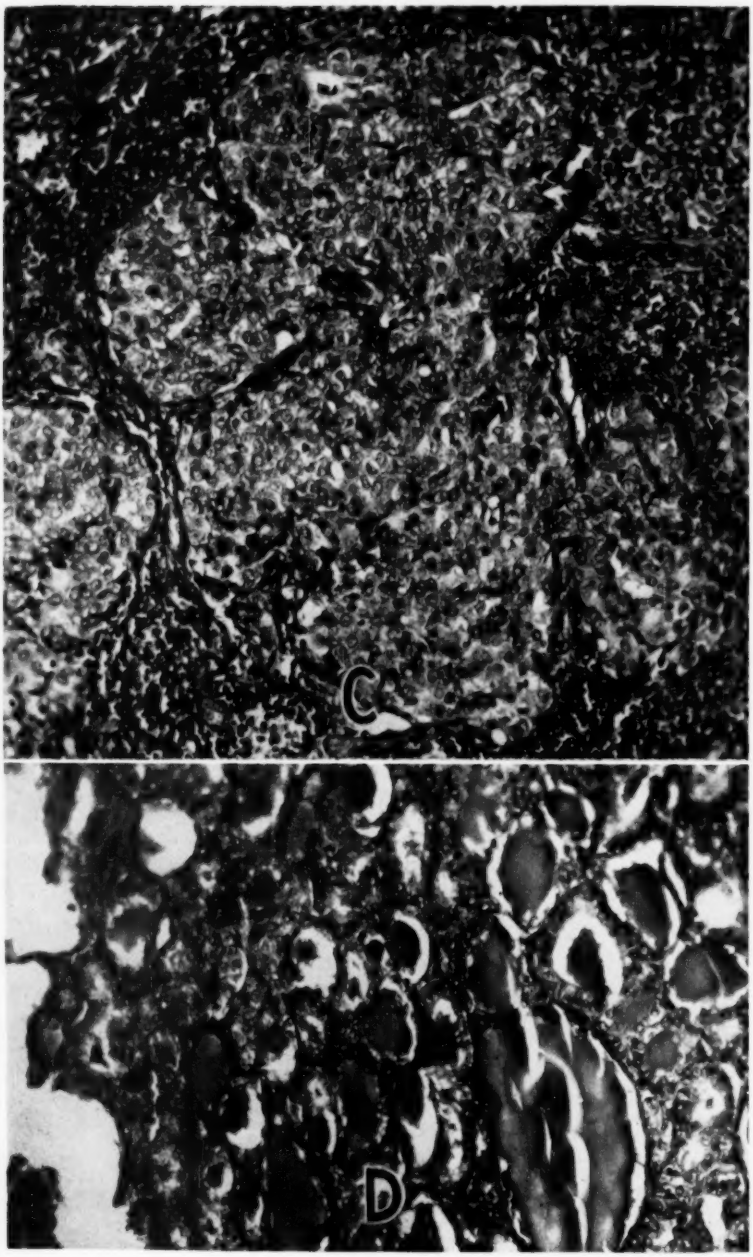


Fig. 1.—*C*, Hürthle cell metastasis in same node as *B*; × 200. *D*, alveolar structure in same node as *B* and *C*; × 200.

tightly encapsulated. If there be hypertrophy or hyperplasia within the gland, pressure within the capsule increases and must be relieved. This results in invagination of cells into the smaller vessels about the capsule. It is this picture which is often wrongly interpreted as blood-vessel invasion. It is not an unusual phenomenon, is not diagnostic of carcinoma, and has also been reported as occurring in many normal adrenals.[4]

Another way in which our pathological findings vary considerably from those reported is with regard to the relationship of the histology of the primary lesion to the histology of the metastasis. A metastasis may take any form, i. e., a papillary tumor may metastasize as a Hürthle cell or acinar type tumor, or vice versa. Careful examination of published case reports [5] which are adequately illustrated will demonstrate that this is also true in these cases, though not recorded. As a matter of fact, in our series the majority of the patients, well over half, showed multiple histologic pictures in the metastases, and often showed two or more types in one lymph node (Fig. 1).

Division of our patients into categories shows the following. Of the 155 patients, 101, who were operated upon because clinically they presented a single nodule, showed multiple nodules on gross examination of the gland. Seventeen patients (11%) had carcinoma of the thyroid. Their ages varied between 5 and 73. The greatest number of patients with carcinoma were between 20 and 40 years of age. Three of the patients were under 12 years of age, and all three had carcinoma of the thyroid. Of the 14 male patients, 7 had carcinoma. Of the 141 female patients, 10 had carcinoma. Incidentally, no cancer was found in 158 patients operated upon for toxic goiter.

Surgical exploration is to be done in the presence of nodules in all women over 18 years of age whose glands show a rapid change in size and consistency without a history of recent pregnancy or hyperthyroidism, and in children and males immediately upon discovery.

It is our feeling that a lobectomy is required for adequate study of a tumor and often is easier than simple excision of the nodule.[1e] Complete removal of the tumor, no matter how accomplished, is essential.

In the group of 27 patients with cancer of the thyroid, 8 were previously operated upon for a nontoxic nodular goiter. The incidence in this small group in which cancer appeared after "prophylactic" operation is approximately 30%. It must be concluded, then, that subtotal thyroidectomy does not insure against having a later cancer of the thyroid, or that the original diagnosis was wrong.

The surgical technique used in the treatment of these patients has been adequately presented.[6] In general we follow the procedures described with little modification. The sternocleidomastoid muscle, unless invaded by tumor, is resected only to facilitate removal of the jugular vein and its chain of lymph nodes. Its removal does increase the deformity. We have achieved complete excision of the

4. McManus, J. F. A.: Personal communication to the authors.

5. Shaw, R. C.: Metastasizing Goitre, Brit. J. Surg. **34**:153, 1951.

6. Black, B. M.: Surgical Treatment of Carcinoma of the Thyroid Gland, J. Clin. Endocrinol. **9**:1422, 1949. Catell, R. B.: More Optimistic Approach to Cancer of the Thyroid, West. J. Surg. **54**:444, 1946. Ward, G. E., and Hendrick, J. W.: Diagnosis and Treatment of Tumors of the Head and Neck, Baltimore, Williams & Wilkins Company, 1950.

diseased tissue with less deformity in two ways: (1) by longitudinal division of the muscle with inclusion of its medial portion in the block resection; (2) by transection of the muscle with reflection of its ends, as is done with the strap muscles

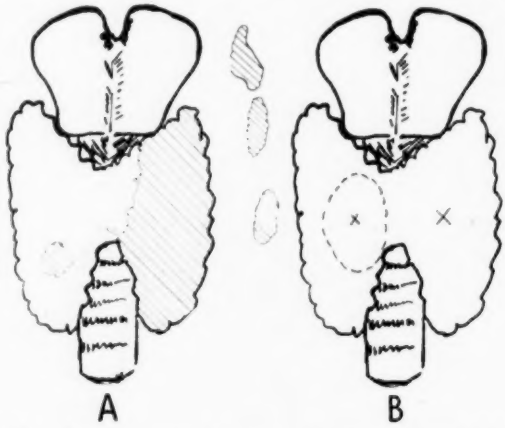


Fig. 2.—*A*, multiple primary or secondary focus of tumor in opposite lobe. Large papillary tumor in left lobe with nodes. Small tumor in right lobe. *B*, tumor deep in right lobe after administration of radioactive iodine shows Geiger count (180 to 190 per second) similar to that in left lobe (190-210).

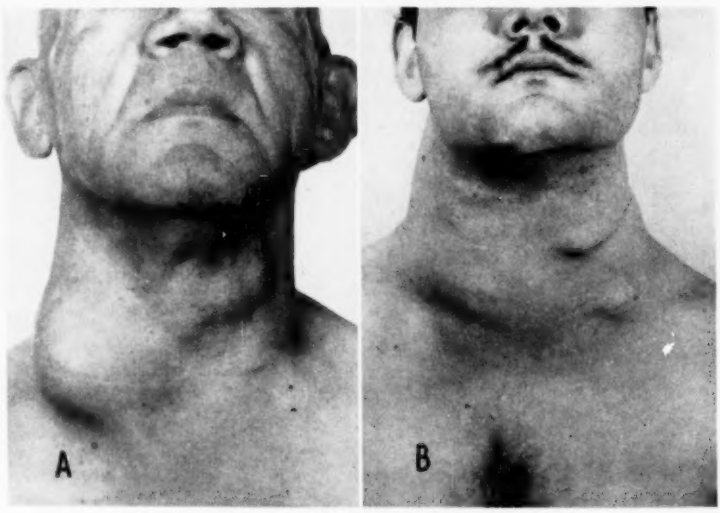


Fig. 3.—*A*, 60-year-old man whose carcinoma was first discovered at surgery in 1919. No further operative procedure until 1950. *B*, 28-year-old man whose history suggests occurrence of primary lesion at age of 5.

in thyroidectomy. In the latter instance the muscle is approximated by sutures in closing. We also recommend "total" thyroidectomy rather than merely the inclusion of the homologous lobes and isthmus in the resection. This practice is based on three

experiences similar to the one illustrated (Fig. 2*A*), in which a tumor or a satellite was in the opposite lobe. Also, this may stimulate metastatic foci to function. The "hunt and peck" removal of nodes is used only when it is necessary to preserve important structures removed during resection of the opposite side of the neck.

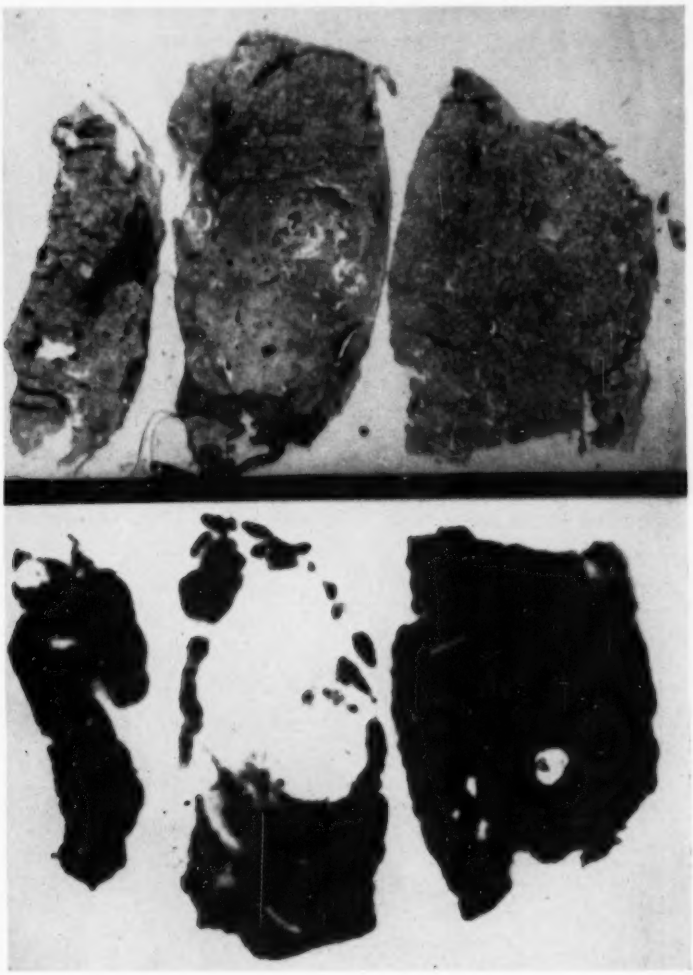

Fig. 4.—Radioautograph of thyroid shows uptake of $I^{131}$ in gland but not in primary tumor.

We have found radioactive iodine to be of little value in the preoperative diagnosis of these lesions. Contrary to the work of Dobyns [7] (hot and cold nodules),

7. Dobyns, B. M.; Bengt Skanse, M. D., and Maloof, F. A.: Method for the Preoperative Estimation of Function in Thyroid Tumors: Its Significance in Diagnosis and Treatment, *J* Clin. Endocrinol. **9**:1171, 1949.

it has been our experience that often a tumor may lie beneath normal thyroid tissue and hence show the same activity after a tracer dose of radioactive iodine as the normal thyroid in the opposite lobe (Fig. 2*B*). Thus we feel that there is no clinical test to substitute for surgical removal of a tumor in determining the presence or absence of a cancer.

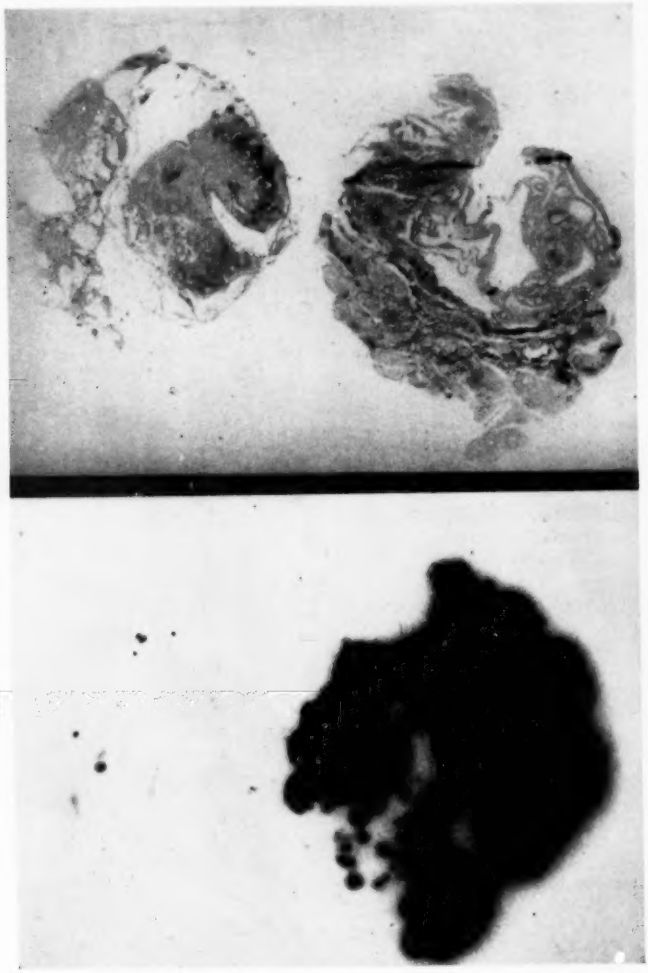

Fig. 5.—Radioautograph shows good uptake in lymph node of same patient as in Figure 4, at same operation.

It is difficult to evaluate the use of radioactive iodine in the treatment of carcinoma of the thyroid. Patients with carcinoma of the thyroid can survive, as did two of our patients (Fig. 3), 20 to 35 years, without specific therapy.[8]

8. Crile, G., Jr.: Papillary Carcinoma of the Thyroid and Lateral Cervical Region, Surg., Gynec. & Obst. **84**:757, 1947.

Patients like these illustrate another problem. This problem arises when the patient presents himself only for relief of obstruction. The mass of tumor may be colossal. The amount of ionizing radiation necessary to treat it would kill the patient. In these instances the accessible mass must be excised. An attempt then may be

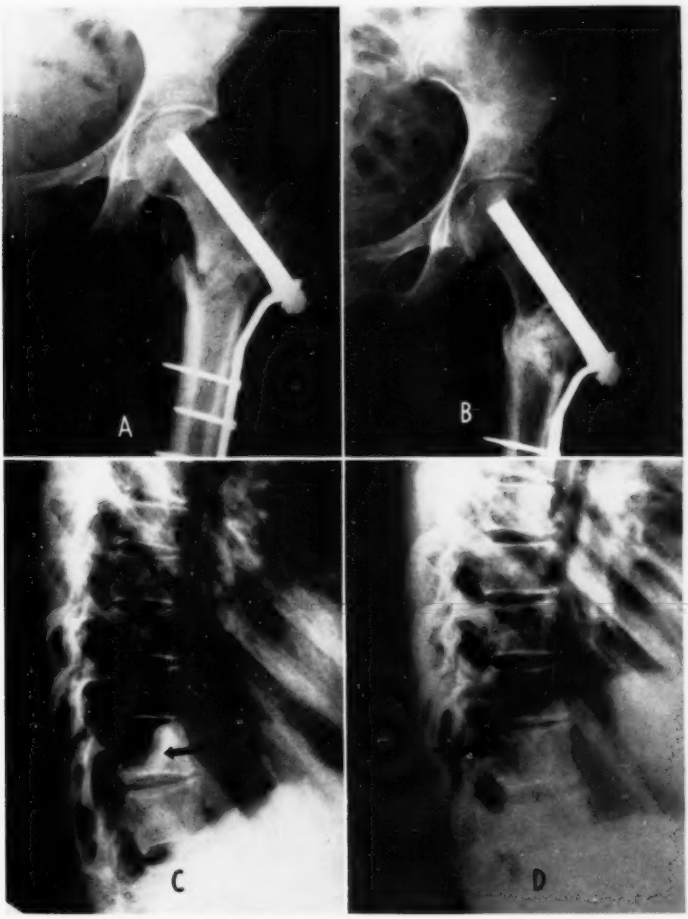


Fig. 6.—*A* and *B*, roentgenograms showing healing of pathological fracture of femur. *C* and *D*, roentgenograms showing healing in spine.

made to treat the remaining tumor tissue with radioactive iodine. If the iodine is not absorbed, there are methods to stimulate an affinity for it.

Our radioautographic studies, in most instances, demonstrate a greater affinity for isotope in the metastatic foci than in the primary tumor (Figs. 4 and 5). Obviously, then, the "up-take" in the primary lesion does not determine the efficacy of this treatment.

We agree with Frantz and her associates[9] in that where bony metastases have healed as a result of radioiodine, there have been no recurrences in patients followed four and one half years (Fig. 6).

## CONCLUSIONS

1. The histopathological examination of thyroid tumors is not as important as gross examination in either the diagnosis or the prognosis.

2. Our incidence of cancer of the thyroid is fairly consistent and is not correlated with a so-called "single nodule" of the thyroid. The "single nodule" of the thyroid is a clinical myth, and cannot be substantiated by gross or microscopic examination in most instances.

3. The method of biopsy must vary with the lesion. We feel that lobectomy is the method of choice. Removal of a nodular goiter is no insurance against the occurrence of cancer.

4. Radical surgery has contributed some to the control of these lesions. However, we feel that 20 to 40 years must pass before the true value of radioactive iodine can be recorded. There are a few instances in which the use of ionizing radiation has been miraculous.

9. Frantz, V. K.; Larsen, W. G., and Jaretzki, A., III: An Evaluation of Radioactive Iodine Therapy in Metastatic Thyroid Cancer, J. Clin. Endocrinol. **10**:1084, 1950.

# MANAGEMENT OF HEAD AND NECK CANCER BY THE GENERAL SURGEON

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THE CARE of patients with head and neck cancers requires familiarity with a variety of skills which at the present time are assigned to several different subspecialties in the medical profession, and this fact probably accounts for the therapy of these lesions lying in a medical no man's land. The otolaryngologist becomes skilled in the examination of the oral cavity, and this skill permits him to discover many primary tumors. His ability to cope with them by major surgical procedures—radical neck dissections, combined neck and jaw resections, etc.—is frequently totally lacking, so that even though he may make the diagnosis he can contribute little to the actual therapy of the patient.

Many radiologists unhesitatingly accept the responsibility for treating intraoral cancers. Yet it is unusual for the average radiologist to be capable of examining, or even willing to examine, the pharynx, larynx, pyriform sinuses, or base of the tongue with a view to appraising the exact extent and delimitations of the primary tumor. Cervical metastases—the commonest complication of intraoral cancer—are more efficiently treated by surgery than by irradiation, and, even though the radiologist may succeed in sterilizing the primary tumor, he has to bow out and turn the patient over to someone else to take care of this eventuality.

The general surgeon or his colleague, the plastic surgeon, may be well qualified technically to perform a radical neck dissection but, again, many times either may lack the willingness to thoroughly examine the oral cavity to find the primary tumor responsible for the whole chain of events or, if he is willing, then is technically incapable of doing so. Farther out on the fringe of those toying with this problem are such persons as "oral surgeons" and "oral pathologists"; they are trained entirely in dental schools, where no opportunity at all exists for gaining familiarity with general surgical techniques.

## REQUIREMENTS FOR OPTIMUM CARE OF HEAD AND NECK PATIENTS

*Knowledge of the Natural History of Tumor Types Occurring in the Head and Neck.*—Accurate diagnosis is generally conceded to be a necessary precursor to the planning of intelligent therapy. It is not my purpose to review the natural history of the infinite variety of tumor types that can occur in this area. Nevertheless, I will take this opportunity to call attention to several points commonly encountered. For example, one should be aware of the hazards of making such a

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Read (by invitation) at the Fifty-Ninth Annual Session of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

diagnosis as branchiogenic cancer. It has now been abundantly proved that a squamous cell carcinoma found in a "lump in the neck" is more likely to be a metastasis from an occult primary within the mouth than to have arisen from such a theoretical source as a branchial cleft.[1] It has been stated that the caliber of work in a tumor clinic may be gauged by the frequency with which the diagnosis of branchiogenic cancer is made. Similarly, the myth of aberrant thyroid cancer is now beginning to be dispelled, and recognition of its true status, viz., a metastasis from a primary in the homolateral lobe of the thyroid, has begun to erode through the wall of skepticism maintained by even the most hardened reactionary. The possibility that a single nodule in the thyroid in actuality is explicable on the basis of cancer and not of a harmless adenoma is a point that has been well driven home to us all.

*Endoscopic Ability.*—The primary tumors responsible for the presence of the mass in the neck and also for other symptoms referable to intraoral cancer may be easy or difficult to visualize. Simple exploration of the intraoral cavity with the examining finger, aided by good illumination, will uncover many primary lesions. There is a second group, in which the use of a laryngeal mirror will be of great aid. In a still smaller group, endoscopic visualization may be necessary. In my opinion anyone undertaking the responsibility for care of these patients should become versed in all aspects of examination of the oral cavity, pharynx, and larynx. It is not sufficient to receive a report from a colleague that the tumor is located on the hypopharyngeal wall, extends down to the level of the tip of the epiglottis, etc., and then have the person responsible for doing the major operative surgery not have any firsthand visual impression of the exact extent of the tumor.

A parallel situation has already occurred in thoracic surgery. When cancer of the lung was first beginning to be accepted as a surgical problem, it was common to have an endoscopist perform bronchoscopy on the patient, visualize the tumor, remove specimens for biopsy, and then describe to the surgeon the exact extent and location of the mass. This has now been superseded by the surgeon doing the endoscopic procedure himself. The utter impracticality of second-hand visualization and knowledge of the extent of the tumor soon became evident, with the result that this unnatural division of responsibility has gone entirely into eclipse and every thoracic surgeon now habitually undertakes the endoscopic examination of his patient as a routine responsibility of his own.

*Knowledge of the Indications and Contraindications of Radiation Therapy.*—Radiation therapy is still an important adjunctive method in treatment of patients with cancers of the oral cavity. Before undertaking a radical surgical procedure in this part of the body, the person responsible for the treatment should ask himself whether or not irradiation could do the job as efficiently and with less morbidity and mortality.

*General Surgical Background.*—It will be apparent from the techniques about to be described that for such operations to be accomplished efficiently, with a high rate of salvage and a low mortality and morbidity, a good background in general surgical techniques is most certainly a prime requisite. Yet even though a surgeon possesses the technical skill to execute the actual operative attack, misguided use

1. Martin, H., and Morfit, H. M.: Cervical Lymph Node Metastases as the First Symptom of Cancer, Surg., Gynec. & Obst. **78**:133, 1944. Martin, H.; Morfit, H. M., and Ehrlich, H.: The Case for Branchiogenic Cancer (Malignant Brachioma), Ann. Surg. **132**:867, 1950.

of these skills will lead to poor results. We still see patients complaining of a lump in the neck concerning whom the first reaction on the part of the surgeon to whom the patient applies for help has been to reach for his knife with the aim of removing this mass. The specimen is then examined in the laboratory; a report of squamous cell carcinoma is returned, and the patient is then referred to the clinic with the diagnosis of "squamous cell carcinoma of the neck."

Obviously a diagnosis such as this is no more complete than if a diagnosis of "adenocarcinoma of the axilla" were made for a woman, with no mention at all being made of the fact that there is a primary tumor in the corresponding breast responsible for producing this axillary metastasis. It is apparent that the removal of the neck mass has not clarified the actual underlying pathology in the patient's case one bit and that until the primary tumor responsible for the neck mass is discovered and some kind of treatment is outlined which will encompass and have as its objective removal of both the primary tumor and the metastasis no cure can be attained. The prudent surgeon would do well to consider as carcinoma all asymmetric lumps in the neck occurring in adults. If he is convinced of this and will make a thorough examination of the oral cavity and train himself so that his examinations are reliable, the patient's welfare will be much further advanced than if his sole contribution is simple removal of the neck mass.

What is the solution, then, to this problem? One of the disadvantages of specialization has been that some of the lines between specialties are too rigidly enforced. Absolute insistence that a member of a certain specialty be responsible for the treatment of any form of human disease should yield to the more solid contention that the individual responsible for the actual therapy should be the one who by training, interest, and inclination has best prepared himself for the job, regardless of specialty lines.

I feel that one who has had the benefit of a general surgical training at the present writing most clearly approximates such a person. It is certainly easier to take a man with good general surgical training and in the course of a few months teach him the use of the laryngeal mirror, laryngoscope, esophagoscope, and bronchoscope than it is to take a radiologist and try to teach him to do a radical neck dissection or a combined neck and jaw resection. To a less degree, the same statements may be made concerning the man trained entirely in otolaryngology, and the ability of the "oral surgeon" in this regard need scarcely even be mentioned.

Many a professor of surgery in the United States today has had an interview with his ear, nose, and throat colleague during which the otolaryngologist has presented a demand to share in the treatment of patients with head and neck cancers. For my part, I feel that there is no reason why the otolaryngologist cannot be trained to meet the requirements of patients suffering with these diseases, but the argument must rest on a firmer foundation than the simple declaration that because a tumor happens to occur in the head and neck and the man is an ear, nose, and throat specialist he is automatically qualified to meet the demands of the situation. I feel that any otolaryngologist who has the interest to train himself to meet these problems should be encouraged; but I also feel that the specialty of otolaryngology has its own responsibility for improving the training of its younger men, which at the present time includes no general surgical background and no knowledge of nutritional disturbances, of parenteral alimentation, etc., so as to better equip its future members with training that will enable them to cope more adequately with these problems.

RADICAL NECK DISSECTION COMBINED WITH JAW RESECTION

There are certain general statements that apply to all tumors occurring in the head and neck. First, they occur in a preponderant ratio of approximately 10:1 in males over females. Cancer of the thyroid and of the salivary glands are the only two exceptions to this rule, in that they occur with approximately equal frequency in the two sexes. Second, like most other forms of cancer, these lesions have their greatest incidence in the middle and latter decades of life. Here again one must except thyroid and salivary gland tumors, which may be found even in children and infants. Third, lymphatic metastases are extremely common, and therefore treatment of a tumor primary within the oral cavity automatically leads one into consideration of the cervical lymph node metastases as well.

However, the most important feature from the standpoint of therapy is the fact that an analysis of the subsequent course of patients receiving treatment for tumors in this location indicates that, even though the case may terminate through uncontrollable disease, the cancer remains confined to the primary site and area of regional spread (neck) in the majority of cases. It is complications arising from the localization of the disease that actually provides the precise mode of exodus. That is, such patients will die of hemorrhage, respiratory distress, or inanition caused by difficulty in swallowing and pain, despite which only a minority [2] will show distant dissemination of disease such as metastases to the lungs and liver. To anyone interested in achieving cures and permanent eradication of cancers occurring in this area this fact has an extremely important message, for if a means of therapy can be worked out that will accomplish eradication of the primary focus plus the regional metastases then a satisfactory and sizable proportion of patients can be saved from death.

The current wider application of radical operations about the head and neck for the control of cancer cannot claim to be new. A review of the older surgical literature concerning these operations indicates that toward the end of the nineteenth century and at the beginning of this current century, operations of this type were tried in this country by George Crile Sr.[3] and in Europe by many other surgeons. The mortality rate and morbidity resulting from these operative procedures were so prohibitive that only a few hardened souls even attempted them and after a period of time they were practically abandoned. The advances in the field of general surgery and better anesthesia have justified a revival of these techniques. Their safety can be attested to by the fact that we are now able to predict an operative mortality of approximately 3% to 4% in these operations. Our own series is still too small and has been followed for too short a time for me to be able to report end-results here. All indications are, however, that the expectant survival rate achieved by this means will far supersede that reached by any other heretofore employed procedure, such as irradiation or limited surgical attack.

2. Peltier, L. F.; Thomas, L. B.; Barkley, H. C., and Kremen, A. J.: The Incidence of Distant Metastases Among Patients Dying with Head and Neck Cancers, Surgery **30**:827, 1951. Braund, R., and Martin, H.: Distant Metastasis in Cancer of the Upper Respiratory and Alimentary Tracts, Surg., Gynec. & Obst. **73**:63, 1941.

3. Crile, G., Sr.: Excision of Cancer of the Head and Neck, With Special Reference to the Plan of Dissection Based on 132 Operations, J. A. M. A. **47**:1780, 1906.

*Indications for Operation.*—In considering the situations in which the combined neck and jaw operation may be indicated, I feel that wherever the tumor invades the bone attack by surgical means is the method of choice. If the neck must be entered in order to take care of the primary tumor, a radical neck dissection should be done at the same time, even though the only clinical evidence of disease may be at the primary site. My salvage rate is better when the neck dissection is done on a "fresh" neck than when it is deferred and done later in a field scarred from a previous operation. Secondly, when cervical metastases are present and the primary tumor within the oral cavity is situated where it is at all possible to remove it at the same time, we feel that the operation is indicated.

Hence, it is seen that the operation has a variety of applications and can be used to take care of cancers of the gum and cancer of the lateral margins of the tongue (the commonest location of tongue cancer), particularly when it has spread down on to the adjacent floor of the mouth or up on to the adjacent gum. Cancers occurring in the tonsillar pillar or on the portion of the tongue adjacent to the tonsillar pillar and even spreading out for a short distance onto the soft palate may be successfully coped with by this operation. A few cases illustrating the application of this technique will be presented subsequently.

*Preoperative Preparation.*—Candidates for this operation require no special preparation other than those measures usually carried out on patients about to undergo any radical operation. Any medical complications are worked up, and the patient is nursed into as good general condition as possible. I am willing to stand with Martin, Abels, and others on the flat statement that there are no medical contraindications to cancer surgery.

*Techniques of Operation.*—The patient is prepared for operation by generous sedation before coming to the operating room. The primary cause of mortality in these operations is respiratory obstruction. This usually occurs within the first 24 to 48 hours after the operation and results from laryngeal edema or swelling of the soft tissues of the tongue and pharyngeal wall resulting from the surgery plus the disturbance of the normal lymphatic flow after removal of the cervical lymph nodes. Accordingly, the first step in the operative procedure is to establish a tracheostomy, and with a simple extension of the usual tracheostomy tube a connection between the tracheostomy and the anesthesia machine can be carried out. By this means a good airway during the actual operative procedure is assured and the tracheostomy tube is left in situ as a safety measure during the immediate postoperative period.

The techniques of radical neck dissection have been outlined in several other places in the literature, and no attempt will be made to cover that portion of the operation at this time. I particularly recommend a recent article published by Hayes Martin in the journal *Cancer* for May, 1951,[4] in which the details of radical neck dissection with a discussion of some of its complications are presented at some length.

In the combined operation the first portion of the procedure is a radical neck dissection with the exception that the neck contents are left attached to the mandible. The lower lip is then split in the midline, and the entire cheek flap is reflected

4. Martin, H.; Del Valle, B.; Cahan, W., and Ehrlich, H.: Neck Dissection, Cancer **4**:441, 1951.

laterally (Fig. 1). This gives wide exposure of the intraoral region, permitting direct visualization of the primary tumor, so that the surgeon has every advantage of cutting sufficiently wide. Despite the advanced age of many of these patients (Fig. 4*B*), the procedure is tolerated very well. In general, patients in advanced age groups will tolerate radical surgery on the peripheral portions of their bodies much better than they will procedures within the abdominal cavity or chest. Gen-

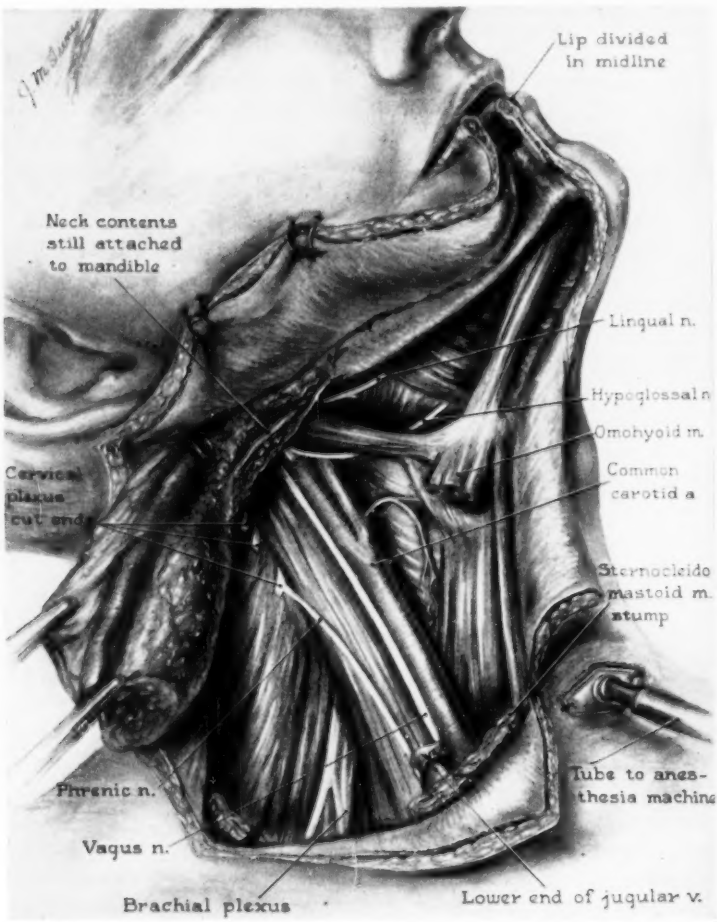


Fig. 1.—Combined neck and jaw resection. The first step in the combined operation is a radical neck dissection. The contents of the neck are left attached to the mandible so that at the completion of the procedure the primary tumor is removed in continuity with the regional metastatic nodes. The first step in obtaining exposure of the intraoral region is to divide the lower lip in the midline. Note the connection of the tracheostomy tube with the anesthesia machine.

erous use is made of blood and antibiotics. The average combined operation lasts approximately four to five hours, and a total of 1500 cc. of whole blood usually suffices to insure that the patient will not go into shock.

The outer surface of the mandible should be exposed throughout (Fig. 2*A*, and *B*). This is accomplished by dividing the insertions of the masseter muscle at the angle of the jaw. If this thick pad of musculature is preserved, the facial nerve is well protected from injury during retraction. Thereafter, the jaw is divided with a Gigli saw at the point of election (Fig. 2*C*). It can then be reflected laterally, giving even wider exposure for the intraoral portions of the operation, and particularly of the tonsillar and pharyngeal areas. It thus becomes possible to cut around the margins of the primary tumor accurately and under direct vision. Once

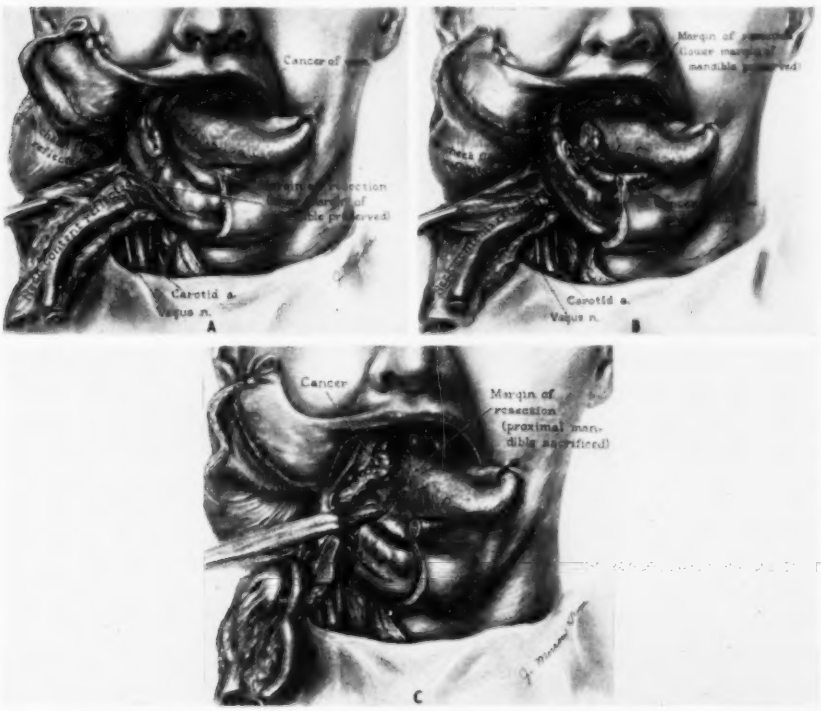


Fig. 2.—*A*, the wide exposure of the intraoral region attained by reflection of the cheek flap is again seen in this drawing. In selected cases the entire full thickness of the mandible does not have to be sacrificed. The primary tumor is extracted from beneath the mandible and removed with the neck contents. *B*, the cheek flap has been reflected, giving generous exposure of the intraoral region and thus permitting the surgeon direct visual control in removing the primary tumor. In selected cases a thin inferior rim of mandible can be preserved, as shown in this drawing. The primary tumor can then be rolled medially and pulled out beneath the mandible in continuity with the neck contents. *C*, to facilitate adequate exposure of the posterior portions of the mouth and pharynx and to aid in closure following removal of the tumor, sacrifice of the full thickness of the mandible is recommended.

this has been accomplished, the only remaining job is to complete the disarticulation of the mandible.

The mandible is one of the most difficult bones in the body to disarticulate. It lies in a rather well protected fossa and has several short bands and muscle groups

attaching to its upper extremity. However, when the jaw has been divided and reflected laterally, the pterygoid muscles will then come into view. These can be cut, leaving the stumps for use in closing the defect later. If the jaw is pulled downward, this will help bring into view the attachment of the temporal muscle to the coronoid process. This is severed, and the only remaining point of fixation is at the condyloid process, which lies in the temporomandibular fossa itself. As each band of attaching musculature is gradually divided, the jaw will become more mobile and access to the temporomandibular fossa becomes easier. The capsule is slit, and the jaw can be twisted and pulled free of its final attachments in this area.

At the conclusion of this operative procedure a large wound is present, extending from the clavicle often to the maxilla (Fig. 3*A*). Saliva from the oral cavity finds access to the open neck wound, but in my experience this has been no disadvantage. Closure of the wound is begun at the most posterior aspect intraorally (Fig. 3*B*), mucosa being sutured to mucosa wherever possible. In the event that the tongue has been included in the specimen which was removed, the cut edge of the lateral border of the tongue is sutured directly to the mucosa of the corresponding cheek. Interrupted 000 chromic sutures are placed at intervals not exceeding 6 to 7 mm. The primary mucosal suture line is buttressed by pulling underlying soft tissues together in an endeavor to eliminate any dead space beneath it. Stumps of muscles (pterygoid, masseter, etc.) may be used for this purpose.

The mucosal suture line is continued until it reaches the midline anteriorly and then is extended up onto the inner surface of the lower lip. This, in effect, amounts simply to backing out of the wound and patiently repairing with interrupted sutures the incision which earlier in the operation was made by the knife. The musculature of the lower lip and chin tissues is then approximated with absorbable surgical (gut) sutures, as is the platysma or other tissues contained in the skin flaps. When the entire wound has been reapproximated with the subcutaneous sutures, the skin itself is then closed with interrupted 0000 nonabsorbable surgical (silk) sutures. Two large Penrose drains are left beneath the skin flaps, one extending into the submaxillary triangle and the other into the temporomandibular fossa, and both are brought out through the end of the wound near the clavicle.

A tape is then tied to the tracheostomy tube, and the latter is firmly anchored in place with a good square knot. It is important to affix this tracheostomy tube firmly before any head dressings are placed in position. Otherwise the tape may overlie the bulky dressings and when the dressings slip out from under the tracheostomy tape there will be slackness in the string, making it possible to dislodge or kink the tracheostomy tube. A large bulky pressure dressing is then applied in such a way as to assure a good airway around the tracheostomy stoma. The patient is then returned to the ward.

*Postoperative Care.*—The most important fact to be remembered in the postoperative care of these patients is that the most probable cause of death is respiratory obstruction. Every effort should be bent to assuring that the tracheostomy tube is patent at all times. This necessitates a suction machine by the bedside and constant nursing care for the first 24 to 36 hours. After this period the patient is usually adequately awake and recovered to the point that he can get along without any

special nursing. I have not encountered any serious postoperative hemorrhage following this operation. There will be continued drainage, as there is from any large wound, for the first 24 to 36 hours. The fluid gradually progresses from red to pink to straw-colored and eventually ceases altogether. Occasionally fluid accumulations may develop in the supraclavicular fossa, but these can be easily cared for.

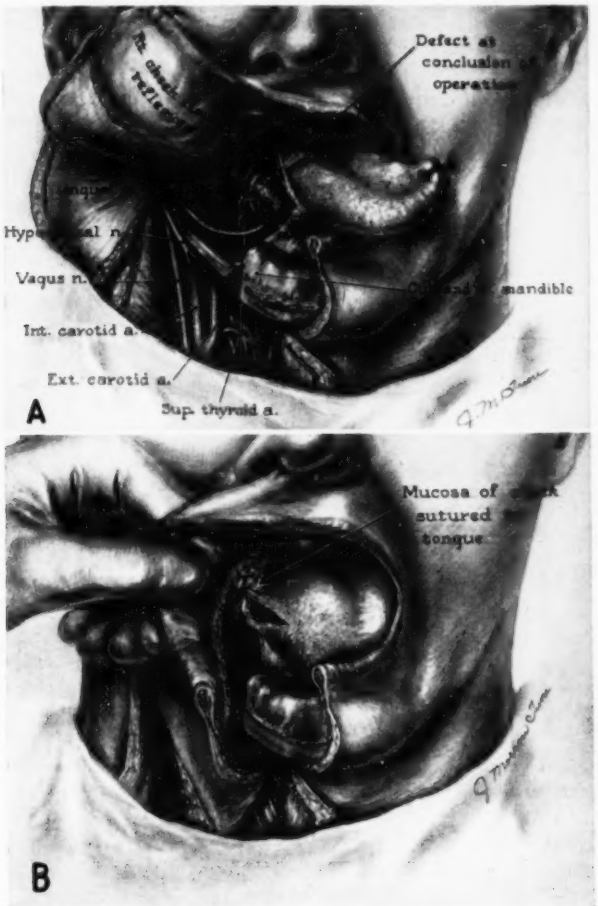


Fig 3.—*A*, postresection defect. A large wound extending from the palatal region to the clavicle is present at this stage of the procedure. Closure is started at the posterior intraoral aspect of the wound, the mucosa of the cheek being sutured to adjacent cut borders of tongue. Sharp edges of the mandibular stump should be smoothed and arranged in such a way that coverage with normal mucosa is possible.

*B*, closure of wound. Muscles stumps and adjacent soft tissues are used to buttress the primary mucosal suture line. This is an important step in preventing subsequent fistula formation. The posterior third of the tongue can be anchored to the adjacent cheek flap without producing any serious limitation or mobility in the tongue with resultant speech deformity. If possible, the anterior two-thirds of the tongue should be closed in such a way as to prevent restrictive scarring. When this intraoral region has been thus closed, the remainder of the neck wound is closed in layers.

*Feeding.*—During the immediate postoperative period and until there is good healing, with resulting assurance that no fistula formation will take place, these patients are fed by means of a nasogastric tube. The swelling of the pharyngeal wall, larynx, etc., subsequent to these operations precludes the ability of the patient to swallow any form of food for several days postoperatively. As a general rule, the maximum edema has passed within 48 to 72 hours, and the tracheostomy tube can then be corked off. If the patient tolerates this for 24 hours under all conditions, it is then considered safe to remove the tracheostomy tube. The stoma itself will close by granulation tissue within seven to eight days.

The nasal feedings are continued until approximately eight days postoperatively. By this time there is usually sufficient healing that the patient can be given small amounts of food by mouth. It is possible in most cases to carry these patients through the procedure with little or no weight loss. Despite the advances which have been made in parenteral alimentation within recent years, there is still nothing that is quite so satisfactory as giving the patient food by way of his normal channels.

It is obvious from the type of operation under consideration here that the digestive tract remains perfectly capable of handling its ordinary functions, and if a method can be provided that will shunt the food around the operative area there is nothing to stop these patients from maintaining a good state of nutrition.

*Cosmetic Result.*—It will be seen from the accompanying photographs that resection of the mandible, provided it is carried out at a point approximately level with the canine tooth, is compatible with a very satisfactory cosmetic result. In any case in which it becomes necessary to sacrifice the symphysis menti, however, a considerable deformity develops (Fig. 7). It is a happy coincidence that the location of most intraoral cancers is such that the anterior curve of the mandible rarely has to be removed.

## REPORT OF CASES

Case 1.—*History.*—A. F., a 73-year-old white married man entered the hospital on May 17, 1948, complaining of a painless sore on the left lower gum of four weeks' duration. There was no history of previous treatment of any kind. This "sore" was discovered by the patient, who noticed a change in contour of the gum while exploring the various recesses of his mouth with his tongue. The past history was noncontributory except for the presence of poorly healed bilateral fractures of the femoral necks, necessitating walking with canes.

*Examination.*—Over the left lower gum there was a friable, granular lesion measuring 3.5 by 2 cm. X-rays of the mandible failed to reveal gross evidence of bone destruction, but the clinical impression was that the tumor extended into the periosteum of the bone. The neck showed nothing compatible with metastatic disease.

*Impression.*—It was the impression that the lesion was a squamous carcinoma of the left lower gum.

*Recommendations.*—In view of the location of this cancer and its close approximation to, if not actual involvement of, the underlying bone, surgical treatment was considered to be indicated.

*Course in Hospital.*—The patient was admitted to the Denver General Hospital on May 21, 1948, and on May 25 a combined neck and jaw resection was carried out after a preliminary tracheostomy had been established. Although there was no clinical evidence of metastatic disease in the neck, a radical neck dissection was done, inasmuch as it was necessary to enter the neck in order to take care of the primary tumor.

Convalescence was without complication. The tracheostomy tube was removed on the fourth day postoperatively, and the nasogastric feeding tube was removed on the eighth day post-

operatively. The patient was discharged from the hospital on June 5, approximately 10 days after the date of operation. Examination in the pathology laboratory of the specimen removed (Fig. 4*A*) showed a squamous cell carcinoma invading the underlying periosteum of the mandible. The bone texture itself was untouched by the disease. The nodes in the neck were free of metastases. In retrospect, it is possible that a marginal resection (Fig. 2*A*) would have been adequate in this case.

*Follow-Up Course.*—The patient has remained well since his operative procedure, now approximately three and one-half years (Fig. 4*B*). Although he is unable to chew his food with any strength because of the loss of a portion of the mandible, nevertheless, a good state of nutrition has been maintained. Prior to the development of the gum cancer, the patient had

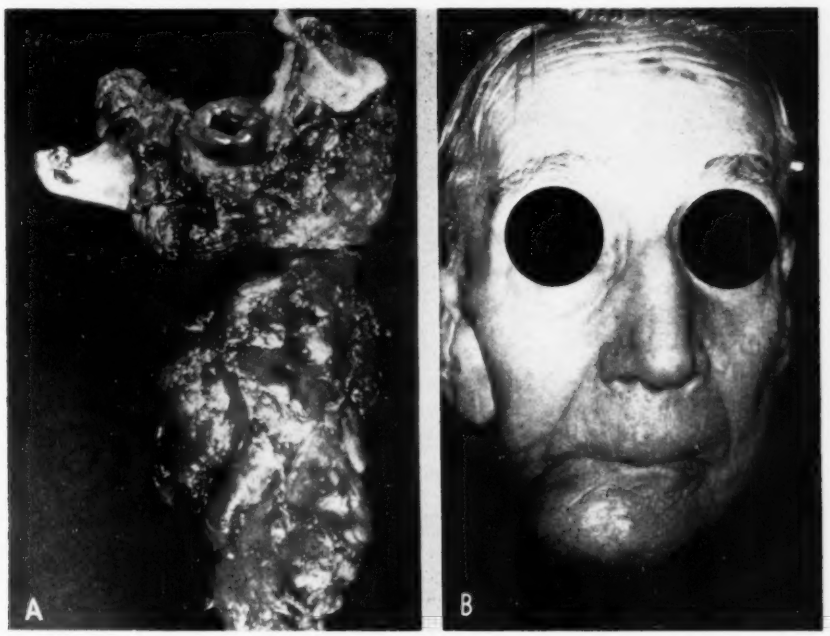


Fig. 4 (Case 1).—Combined neck and jaw resection executed for carcinoma of the gum. *A*, actual photograph of gross specimen showing ulcerated lesion on right mandible removed in continuity with metastatic cervical nodes. *B*, photograph taken six weeks after the operation. This procedure is well tolerated in patients in advanced age group. Note shifting of mandible to right side, where defect in right jaw is present. This deviation is a variable feature. In general, it is more marked in older patients. If the patient has teeth, the shift can be largely prevented by interdental wiring during the immediate postoperative period, which will aid in preventing scar contracture.

been edentulous for many years and had already become accustomed to eating a mechanical soft diet.

Case 2.—*History.*—J. P., a 38-year-old white married man with a history of active tuberculosis first diagnosed in April, 1946, was admitted to the Fitzsimons General Hospital for treatment of this condition. He responded well under pneumothorax therapy to the point that he was being considered for discharge from the hospital.

At this point (April, 1948) a mass appeared in the left neck at the level of the carotid bulb bifurcation. In view of the previous history of tuberculosis, it was assumed that this mass

represented tuberculous adenitis. For this reason no specific therapy or attention was paid to this mass. It continued to grow over the succeeding three months, however, and in June 1948 the patient began to complain of a sore throat on the left side. Intraoral examination revealed a ragged, granular tumor, measuring 3 by 2 cm., centered in the lateral margin of the tongue and spreading up onto the left tonsillar pillar. A biopsy was reported as indicating squamous cell carcinoma. Aspiration biopsy of the left neck mass revealed it to be due to metastatic carcinoma.

*Impression.*—The impression was that the lesion was a squamous cell carcinoma of the left side of the tongue, with cervical metastases.

*Recommendation.*—Combined neck and jaw resection was recommended.

*Course in Hospital.*—On June 12, 1948, a combined radical neck dissection and resection of the mandible was carried out. Convalescence was uncomplicated. The tracheostomy tube was

Fig. 5 (Case 2).—*A*, gross specimen showing primary lesion on tongue resected in continuity with cervical metastatic nodes. *B*, anteroposterior view of patient taken six weeks postoperatively.

removed on the fifth day and nasogastric feedings were continued for 8 days, at which time the patient was placed on a soft diet by mouth. The wound healed without complication, and the patient was discharged on June 28.

*Follow-Up Course.*—The patient has continued to receive careful follow-up examinations for his tuberculous condition but has not shown any evidence of recurrence of the cancer (three years and three months postoperatively). The lack of cosmetic deformity which is encountered when one is able to sacrifice the mandible only from the level of the canine tooth posteriorly to the temporomandibular joint is evidenced in the photograph (Fig. 5*B*).

CASE 3.—*History.*—J. O. B., a 60-year-old white married man applied to the Bonfils Tumor Clinic on Dec. 12, 1950. He complained at that time of a fungating lesion on the right buccal mucosa. Examination revealed a papillary lesion measuring 2.5 by 3 cm. centered in the

right buccal mucosa at the line of occlusion. A biopsy was reported as papillary squamous cell carcinoma. This tumor was excised without complication. It was noted at this time that there were several other areas on the right lower gum and the lower buccal mucosa that were involved by leucoplakic changes of an advanced character indicating the possible subsequent development of a separate squamous cell carcinoma.

On July 3, 1951, the patient reported back to the tumor clinic and a separate focus of disease was seen centered in the region of the right lower gum. This area measured 3.5 by 4 cm. and spilled down onto the adjacent lateral gingivobuccal gutter and for a short distance up onto the lower buccal mucosa. A biopsy specimen was taken, and a report of squamous cell carcinoma was returned. Examination of the neck at this time failed to reveal any clinical evidences of cervical metastases.

Fig. 6 (Case 3).—*A*, gross specimen showing large fungating lesion centered on right gum. The extension onto the buccal mucosa is not illustrated in this photograph. *B*, lateral view taken three months postoperatively.

*Impression.*—The impression was squamous cell carcinoma of the right lower gum and buccal mucosa.

*Recommendations.*—Combined neck and jaw resection was recommended.

*Course in Hospital.*—On July 19, 1951, a combined radical neck dissection with resection of the right mandible was carried out (Fig. 6*A*). Tracheostomy was incorporated as an integral part of the operative procedure. The postoperative course was uneventful. The tracheostomy tube was removed on the third day; nasogastric feedings were continued for six days, at the end of which use of a soft diet was begun. He was discharged on Aug. 4, for further follow-up in the tumor clinic.

*Follow-Up Course.*—This patient had been edentulous for many years prior to this operative procedure and has continued to subsist on a mechanical soft diet without difficulty. There is no crippling cosmetic deformity (Fig. 6*B*). The pathology examination confirmed the presence

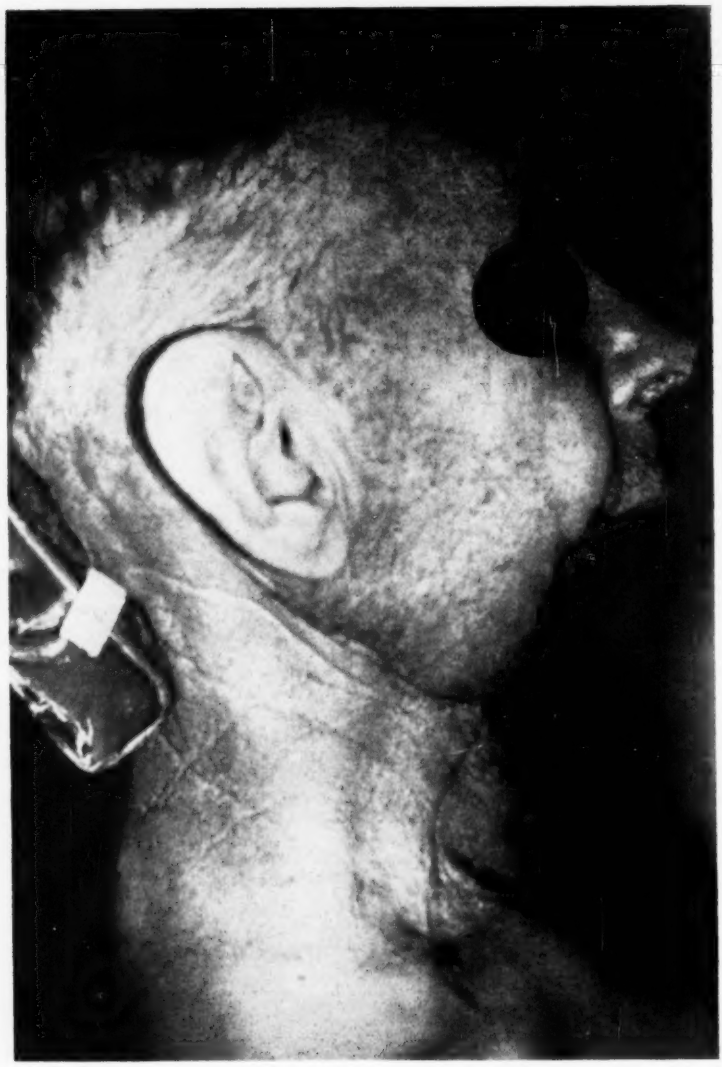

Fig. 7 (Case 4).—Lateral view showing typical "Andy Gump" appearance resulting from sacrifice of anterior curve of the mandible. It is a happy coincidence that the location of most intraoral cancers is such that the symphysis menti rarely has to be sacrificed.

of the squamous cell carcinoma on the right lower gum and buccal mucosa, but the cervical lymph nodes were reported as free from cancer. Here, again, inasmuch as it was necessary to enter the neck in order to remove the mandible, which was the site of the primary tumor, it was considered advisable to include the radical neck dissection at that time.

CASE 4.—*History.*—G. G., a 62-year-old white married man, entered Colorado General Hospital on Nov. 23, 1948, with a history going back as far as February, 1947. At that time he was treated for a squamous cell carcinoma of the lower lip with a cautery. Within a few months the lesion recurred and he received radiation therapy to this recurrence. In another few months the lesion recurred again and he was started on a series of local excisions. The first of these was apparently a simple V-excision. The lesion recurred again following this and he had a second excision. In August 1948 a mass of nodes developed in the right submaxillary triangle, and this mass was opened and drained. The supposition at this time was that he had an actinomycotic infection of his lower lip and jaw. He failed to respond to any of these measures, and a biopsy subsequently indicated that the entire difficulty was on the basis of recurrent carcinoma of the lip, which had spread to the lymph nodes in the neck, and he was then referred to the Bonfils Tumor Clinic.

*Examination.*—There was an extensive recurrence in the lower lip and chin, measuring about 3 by 4 cm. There was infiltration through the entire thickness of the lower lip and chin and into the underlying mental arch of the mandible. There was a large mass of partially necrotic metastatic carcinoma centered in the region of the right submaxillary triangle. The adjacent portion of the mandible to these nodes was unquestionably involved with disease.

*Impression.*—The impression was advanced primary squamous cell carcinoma of the lower lip, with cervical metastases, on the right.

*Recommendations.*—Combined neck and jaw resection was recommended.

*Course in Hospital.*—On Nov. 30, 1948, the patient was operated upon and a right radical neck dissection together with a resection of approximately two-thirds of the lower mandible was carried out. Although at the time of operation it was felt that the mandible had been sacrificed at a level that was free of invasion of cancer, pathology examination of the specimen indicated that the cut margin of the mandible was involved in disease. Accordingly, the patient was returned to the operating room, and the remaining portion of the mandible was excised.

The patient's airway remained uncompromised owing to the presence of a tracheostomy tube, and his nutritional status was maintained by nasogastric feedings. As a result of the sacrifice of the entire mental arch, this patient had the typical "Andy Gump" appearance (Fig. 7). His convalescence was marred by a temporary period of cardiac failure, from which he recovered after treatment with digitalis, bed rest, and dietary restrictions. He was discharged on Dec. 23, twenty-four days postoperatively.

*Subsequent Follow-Up Course.*—Within three months following this radical procedure recurrent disease developed in the soft tissues of the patient's neck. Despite efforts to control this with radiation therapy, there was continued progress of the disease, and ultimately numerous recurrences developed throughout the operative field. Eventually cervical lymph node metastases developed on the left side of the neck as well, and the patient finally died, on Aug. 8, 1949. Despite the extensive spread of disease throughout the primary and regional area, the patient never at any time showed clinical or roentgen evidence of chest metastases. The ultimate cause of death was esophageal obstruction, leading to inanition, and pain due to growth into the brachial and cervical plexus, with gradual occlusion of the tracheal airway below the tracheostomy opening.

## SUMMARY

There is a great division of responsibility in caring for patients suffering from head and neck cancer. Reasons contributory to this factor are lack of wide experience of any single individual due partly to the relative infrequency of these tumors plus a demand for a variety of skills that are at present considered the responsibility of several different medical subspecialties. A knowledge of the natural history of tumors occurring in this area plus some endoscopic ability, familiarity with the

indications and contraindications for radiation therapy and a good basic general surgical training are required in meeting the demands of therapy of these tumors. At the present time the general surgical training places the physician in the best position to attempt to handle these problems.

Tumors of the head and neck metastasize to the regional lymphatics in a high proportion of cases. Even though a patient may die through uncontrolled disease only a minority will demonstrate at autopsy distant dissemination. Radical surgical attack designed to remove both primary and regional cervical lymphatics meets the demands of this situation in many patients. The operation should not be reserved for the advanced cases only any more than a radical mastectomy should be carried out only in large breast tumors and a simple mastectomy in the smaller breast tumors. The techniques of the operation of combined neck dissection and jaw resection are discussed.

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# APPLICATION OF COMBINED HEMIMANDIBULECTOMY AND NECK DISSECTION TO ORAL CARCINOMA

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DURING the course of a follow-up study on 186 patients with intraoral cancer a number of interesting facts were encountered that were worthy of further consideration and that led to further clarification of our therapeutic approach. Many observations of others have been confirmed, the most striking of which is that the cure rate for intraoral carcinoma (other than that of the lip) remains distressingly low. While this had been appreciated to some extent during the course of observing and treating these unfortunate patients, the statistics were such as to encourage me to analyze further the clinicopathologic data with the hope that the total patient salvage might be increased.

Shortly after the study began, it became obvious to my colleagues and me that, although many of these lesions should lend themselves to early discovery, we were not seeing the patients under ideal circumstances. Many presented advanced lesions when first seen. X-ray therapy often was the only treatment suggested, palliation being the only goal. Until recently, in the event that the primary lesion disappeared under such treatment, definitive extirpation was uncommon, as was also the use of block neck dissection for the elimination of deep jugular lymph node metastases. The biologic history of these cancers could well be studied in this group, especially with respect to the demonstration of local recurrences and the persistence of metastatic tumor in captive form within the cervical nodes for many months prior to the development of fatal distant metastases.

A second group of patients were those who presented operable lesions but who were not fit candidates for surgery because of serious cardiovascular disease or other complicating geriatric pathology. Radiation again seemed better suited to these patients. We now appreciate more vividly the interesting fact that some of these primary cancers were radiocurable but that their lymph node metastases were not. A review of these case records shows a high correlation between further growth of lymph node tumor deposits and eventual plans for the patient's terminal care. Had safe conduct through surgery been assured such patients, radical neck dissection might have been of some value to a few.

A parallel group of patients were those who presented a primary lesion favorable to use of radiation in a host otherwise healthy and in whom there was some question concerning the presence of lymph node metastases. After the primary tumor had

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been properly controlled, the question of routine versus therapeutic radical neck dissection often arose for consideration. In most instances this actually in practice became a therapeutic dissection, since a considerable degree of delay can be found in these records. In addition, there was significant variation of opinion, not only within our own group but within members of other institutions, concerning the value of routine neck dissection. During the period of postirradiation observation and the later immediate follow-up period, the nodes frequently enlarged, and thus decision in favor of therapeutic dissection became evident automatically. From this group of patients the indications for radical neck dissection can be drawn and the principle of discontinuous or dissociated therapy elaborated.

Since the great majority of oral carcinomas do not invade blood vessels early, it is evident that complete control of the disease depends largely upon elimination of the primary lesion, with adequate excision of those regional lymph nodes which contain metastases. Among those patients who lend themselves well to treatment for purposes of cure, there has evolved in many centers a plan of dissociated therapy which consists essentially in elimination of the primary cancer by irradiation or by excision followed by radical neck dissection when the cervical nodes are thought to contain cancer and after the primary lesion is under control. Because these tumors metastasize by lymphatic embolization, there has been a tendency for the therapy of the primary lesion to be a separate maneuver, with eradication of the related nodes a matter for later consideration. Not only in our hands but in the experience of others this program has produced some salvage. Unfortunately, a high local recurrence rate of both the primary and the secondary cancer was quite evident in our follow-up study, an observation which adds credence to the view that this plan represents a compromise of the now well-known concept of what constitutes a good cancer operation (as exemplified by the modern radical mastectomy or the abdominoperineal resection of the rectum). Such recurrence gives rise to simple questions such as the following: the need for surgical excision of the primary tumor either before or after irradiation; more complete use of the technique of block neck dissection; the need for bilateral neck dissection, and, the most significant of all, the need for the application of the principle of dissection and excision in continuity.

In a breakdown of the study on local recurrence of the primary lesion, it was found that gingival carcinoma led the list. This was found to be correlated with a high incidence of both bone involvement and enlarged cervical lymph nodes, but, because the latter was realized largely only in retrospect, resection of portions of the mandible was carried out some years before the more frequent need for neck dissection became apparent. Acting on this realization, I elected to fuse the two forms of excisional therapy, and so it was that carcinoma of the lower gingiva became the first intraoral cancer to be treated by me on the basis of the principle of dissection and excision in continuity of the primary lesion and probable secondary lesions. The immediate results of this procedure have been so gratifying that an analysis of our data has been made with the hope that further extension of its use to other types of oral cancer may be justified.

Although the oral cavity produces at least 10 or 12 separate clinical varieties of carcinoma, consideration of the various anatomical sites according to the way in which they lend themselves to therapy is practical. Our study has revealed that a high degree of clinicopathological similarity exists among those cancers arising from

the lower gingiva, the buccal mucosa near the lower gingiva, the nearby floor of the mouth, and the anterolateral two-thirds of the tongue. These constitute approximately 40% of all oral cancers. The essence of this similarity consists in the fact that each produces a substantially high percentage of early lymph node metastases which are so located that both the primary lesion and the secondary lesions can be excised in continuity. The operation of our choice for this procedure is an en bloc dissection of the related deep jugular lymphatics plus a hemimandibulectomy to complete or facilitate excision of the primary lesion. While this procedure is not original with us, our present opinion is based upon experience gained from 106 patients with lesions localized to the above areas, 46 of whom underwent radical

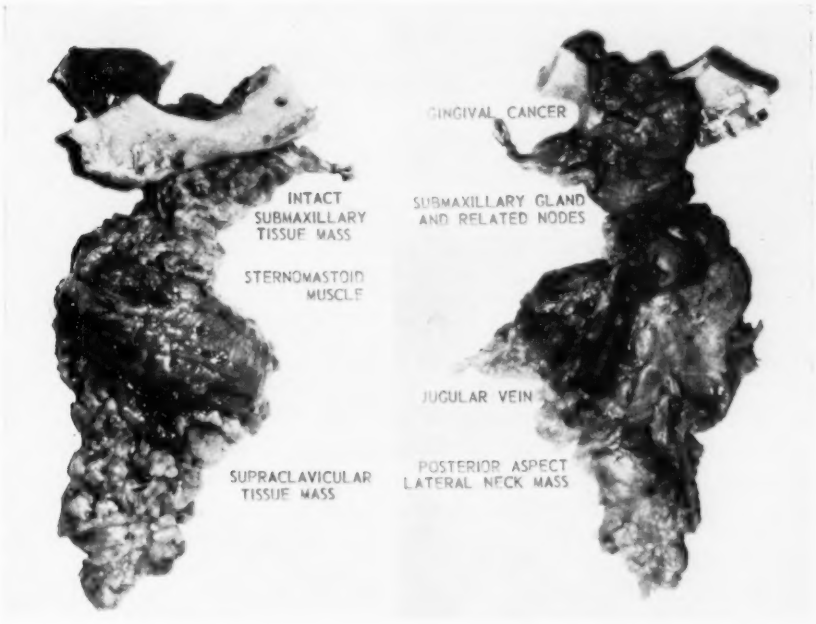


Fig. 1.—Specimen obtained by combined orocervical excision. Left, invasive carcinoma of lower gingiva removed in continuity with mandible and tissues of right radical neck dissection; right, posteromedial aspect, demonstrating preservation of lymphatic drainage between primary lesion and jugular nodes.

neck dissection with or without excision of the primary tumor in continuity. In an effort to solve the problem of proper selection of patients for the application of this surgical principle, some further description of these pathologic entities will be presented.

## CARCINOMA OF THE LOWER GINGIVA

Cancer of the lower gingiva formerly was regarded as relatively benign, showing many of the tendencies of buccal mucosa carcinoma rather than those more malignant characteristics of growths arising from the tongue and floor of the mouth. Our experience and that of others proves that this is not the case. In some series the tendency toward cervical lymph node metastases has been reported as

high as 65%.[1] Local contiguous spread from the primary growth is common, and osteoradionecrosis from previous treatment may compound the problem. Mattick and Meehan [1a] recently reported on 101 patients with cancer of the gingiva who had been treated entirely with radiation. No patients with either node or bone involvement were cured. From observations such as these, as well as our own practice, we have found that radical neck dissection combined with hemimandibulectomy in continuity will increase the rate of salvage from this treacherous malignant neoplasm.

*Operative Procedure.*—With the patient under endotracheal anesthesia, the usual curving T-incision is made so as to fashion appropriate skin flaps as for the accepted technique of radical neck dissection.[2] We include the platysma muscle in the skin flaps when possible. After division of the clavicular end of the sternocleidomastoid muscle, the deep jugular vein is carefully ligated and divided. After the inferior belly of the omohyoid muscle is divided, the contents of the supraclavicular triangle are dissected free from their lateral and deep attachments. When the superior belly of the omohyoid muscle is divided, the jugular mass is elevated and freed from the carotid artery. The vagus and phrenic nerves are carefully preserved. Dissection is carried medialward above the superior thyroid artery and the lip divided in the midline to gain access to the oral cavity. As much as possible of the masseter and pterygoid muscles should be excised with the mandible to include the lymphatics draining the gingiva. After section of the mandible, an appropriate amount of adjoining soft tissue is included in order to encompass the tumor. As the specimen falls lateralward, the upper ligation of the jugular vein is accomplished near its point of cranial emergence. The wound is closed simply by apposing the cheek to the cut edge of the tongue and floor of the mouth. Adequate blood replacement and a temporary tracheostomy eliminate many difficulties that might otherwise develop during the immediate postoperative period. Figure 1 shows a typical specimen obtained by this technique.

### CARCINOMA OF THE FLOOR OF THE MOUTH AND ANTEROLATERAL TWO-THIRDS OF THE TONGUE

Carcinoma of the floor of the mouth and carcinoma of the lateral two-thirds of the tongue should be considered as a single entity not only because of the great similarity in their embryological and anatomical relationships but also because of their similarity in tumor pathogenesis and the manner in which they lend themselves to treatment. Squamous cell carcinomas of these areas metastasize freely to the regional lymph nodes, an incidence of 70% being a good average of involved nodes when seen for definitive treatment.[3]

In the past years our treatment of choice for moderately advanced lesions of this area has been radiotherapy followed by ipsilateral radical neck dissection after the primary tumor had been controlled. The ability of radiation, whether external or interstitial or some combination of the two, to sterilize the primary lesion completely is a matter of some question at this time. In surgically excised and previously irradiated carcinomas of the tongue, Ward and Hendrick found 21% of the patients

1. (*a*) Mattick, W. L., and Meehan, D. J.: Carcinoma of the Gum, Surgery **29**:249-254, 1951. (*b*) Sharp, G. S., and Wood, R. C.: The Treatment of Cancer of the Gums, J. Oral Surg. **8**:185-203, 1950. (*c*) Taylor, G. W., and Mathanson, I. T.: Lymph Node Metastases, New York, Oxford University Press, 1942, pp. 153-158.

2. Carroll, W. W.: Role of Radical Neck Dissection in Oral Carcinoma, Quart. Bull. Northwestern Univ. M. School **25**:353-365, 1951.

3. Gibbel, M. I.; Cross, J. H., and Ariel, I. M.: Cancer of the Tongue, Cancer **2**:411-423, 1949.

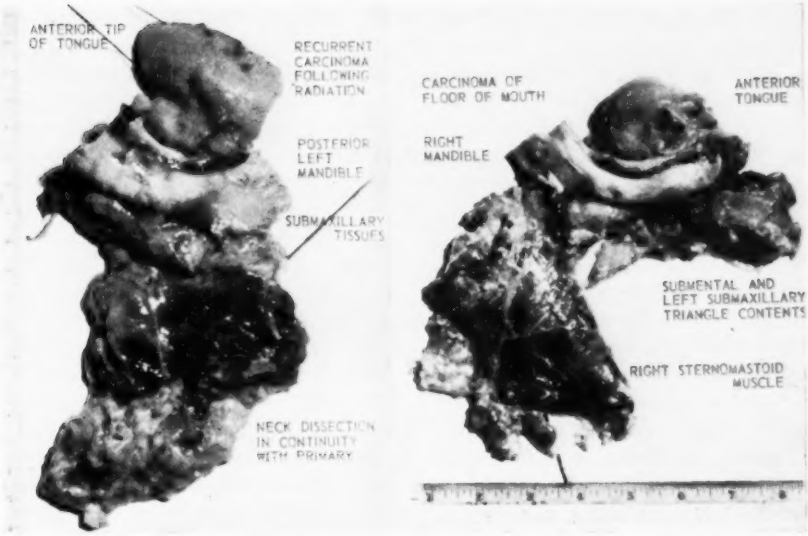


Fig. 2.—Specimen obtained by combined orocervical excision. Left, postirradiation recurrence of squamous carcinoma in left side of tongue and floor of mouth. Right, ulcerated carcinoma of anteromedial aspect of right side floor of mouth removed by means of hemiglossectomy, hemimandibulectomy, right radial, and left suprahyoid, neck dissection in continuity.

Fig. 3.—Photographs taken after hemimandibulectomy with right radical neck dissection. Note preservation of facial contour when some of bone is preserved near midline.

to have persistent tumor.[4] Various others report 36, 58, and 68% in whom the primary lesion was radiologically uncontrolled, i. e., either failed to heal under radiation therapy or recurred promptly.[5] These data suggest that wide surgical excision of the primary lesion after irradiation might well increase the over-all cure rate.

From the standpoint of the regional lymph nodes we remain firm in our belief that routine neck dissection is the best tool for the control of cervical metastasis.[2] While it is well known that the great majority of intraoral carcinomas metastasize into the ipsilateral jugular nodes, it occasionally is forgotten that in about 50% of all normal persons the lymphatics of the tongue and floor of the mouth pass through the periosteum of the mandible as they drain into the submaxillary or subdigastric nodes.[6] This relationship must be remembered in any consideration of the technical aspects of neck dissection or in any effort directed toward combined eradication of these cancers when they lie close to the mandible. In the latter instance we have come to the conclusion that the most practical method of solving the problem is to excise the primary lesion and the nodes in continuity by adding hemimandibulectomy to the procedure. At the present time we are faced with the fact that such an imposing operation is producing good results in instances of postirradiation recurrence or extensive primary involvement. On the other hand, we are withholding this procedure from patients with less extensive cancer who undoubtedly would benefit to a greater extent. This suggests that the indications for this more formidable procedure might be justifiably extended.

If this is accepted as logical and if the lesion approaches the midline, a simultaneous contralateral submaxillary dissection in continuity should be added because of the increased risk of cross metastases. The finding of involved nodes on the opposite side calls for a complete deep jugular dissection at a later date.

## COMMENT

The postoperative course experienced by patients undergoing the combined procedure has been remarkably free of complications. The danger of serious infection has been reduced to a minimum by the routine use of penicillin. Drainage and compression dressings have encouraged prompt wound healing with a minimum of subcutaneous serum collections. In only a few instances have there been difficulties in healing related to previous irradiation. The use of tracheostomy has become routine, and so the maintenance of a patent airway is accomplished with ease. The one death in the series occurred in a tracheostomized patient in whom a mucus plug developed because of inadequate cleansing by catheter suction. In this instance the removable inner sheath was shorter than the outer and the plug developed at

4. Ward, G. E., and Hendrick, J. W.: Tumors of the Head and Neck, Baltimore, Williams & Wilkins Company, 1950.

5. Jorstad, L. H., and Verda, D. J.: Cancer of the Tongue: Its Diagnosis and Treatment, Surg. Clin. North America **27**:1077-1088, 1944. Sharp, G. S.; Demaree, E. W., and Pugh, R. E.: Radiation Versus Surgery for Cancer of the Tongue, West. J. Surg. **58**:257-270, 1950. Lawrence, Edwin A., and Brezina, P. S.: Carcinoma of the Oral Cavity: 10 Year Survey in General Hospital, J. A. M. A. **128**:1012-1016 (Aug. 4) 1945.

6. Polya, A. E.: Technique of Operations for Carcinoma of the Buccal Mucous Membrane, Surg., Gynec. & Obst. **43**:343-354, 1926. Polya, A. E., and Navrath, D. V.: Untersuchungen über die Lymphbahnen der Wangenschleimhaut, Deutsche Ztschr. Chir. **66**:122-175, 1902.

the lower end within the trachea. A false sense of security thus developed when repeated investigation revealed the inner tube to be clear.

An indwelling nasogastric tube is helpful in obtaining efficient alimentation during the first 10 days. The patient must learn to initiate the deglutition reflex properly and to swallow without spilling food into the larynx. Owing to various degrees of tongue fixation, the postoperative rehabilitation requires more time for some than others. Because of this, we have no set rule in regard to the time for withdrawal of the tracheostomy tube. Although the latter is an excellent safeguard in the event of spillage of food into the respiratory tree, we have noticed rapid improvement in swallowing once it is removed. The patients have been able to maintain a good state of nutrition despite the absence of half the lower mandible. The cosmetic results are similarly satisfactory, as evidenced by the accompanying photographs (Figs. 1, 2, and 3).

It is very important to warn these patients in advance that they will suffer varying degrees of difficulty in phonation. About 8 to 10 weeks is required for return of good conversational ability, and a mild permanent defect can be expected in the majority. The dental tones frequently remain slurred and, owing to the lateral attachment of the tongue, the vocal effect is sometimes similar to that achieved when one tries to speak with food in the mouth.

## SUMMARY

In an effort to improve our results in the control of oral cancer a follow-up study on 186 patients was undertaken. Analysis of some of the data suggested that there is a high degree of clinicopathologic similarity among those cancers arising from the lower gingiva, the buccal mucosa near the lower gingiva, the nearby floor of the mouth, and the anterolateral two-thirds of the tongue. The essence of this biologic similarity consists in the fact that each produces a substantially high percentage of early lymph node metastases which are so located in the neck that both the primary lesion and the secondary tumors can be excised in continuity.

Review of the cases of 106 patients with lesions arising from the above-listed areas revealed that 46 radical neck dissections were performed either with or without excision of the primary lesion in continuity. In instances of discontinuous therapy (radiation therapy for the primary cancer and delayed neck dissection for lymph node metastases) the cure rate was not impressive and local recurrence was frequent.

Analysis of the excisions in continuity revealed that radical neck dissection combined with hemimandibulectomy and partial glossectomy, while more formidable, appears to be a more encouragingly thorough and physically acceptable procedure. For many of these patients hemimandibulectomy is an essential part of the operation, while for others it must be added to diminish the possibilities of local recurrence or to eliminate the persistent pain of previously established osteoradionecrosis. Patients receiving this type of treatment have done remarkably well, but for the present it is too early to report long-term survival rates. Suffice it to say that a high degree of morbidity has been eliminated. Patients have been rehabilitated rather quickly, and early recurrences have not been a source of difficulty.

## DISCUSSION

Dr. Paul W. Greeley, Chicago: I agree completely with all the last three papers, and I have no arguments against any of them. If there is one thing in which I do believe, it is that all fractures of the edentulous jaw should have some type of internal fixation, whether it be by wire or by pins. There is probably nothing more insecure than fixation of a fracture of this type with extraoral apparatus, such as the Roger Anderson splint, or with the plaster head cap and traction. One point that Dr. McDowell did not stress in his paper is that patients treated in this manner are all very comfortable as well as secure during the time of immobilization.

Regarding the treatment of intraoral carcinoma, I can also say that I agree that those problems do not belong to the dentist or the oral surgeon, and the majority of them should be handled by a well-trained general surgeon, for they involve major surgical procedures.

One phase which was not touched upon is the fact that many patients will shy away from what seems to be a mutilating type of surgical operation just because of the cosmetic result which may follow that type of treatment. They should all be reassured and told that, should a deforming and disfiguring type of surgical procedure have to be carried out in order to cure a cancer, there are many types of reconstructive procedures available and that after they have been performed a patient can go out and face society and be a reasonably normal human being. This applies to treatment not only of extensive carcinomas but also of damage of the facial nerve which frequently follows adequate parotid tumor surgery.

Dr. H. Mason Morfit, Denver: I want to comment on only two matters which I didn't have time to mention before: first of all, the mortality rate following these procedures—at present this is down to between 1 and 2%—and second, the type of long-term survivals that may be expected.

So far as I know, these procedures have not been done on a very wide scale except since 1944. They were done earlier than that, of course, but with reluctance because of the high mortality rate. With the advances which have enabled us all to do more extensive surgery, they have been rejuvenated, but in this seven-year period there is little chance to study the five-year figures. However, at the Memorial Hospital in New York, this type of surgery is being done on approximately an 80 to 90 a year basis, and a considerable series of cases is piling up. I was informed by Dr. Martin a few weeks ago that a study of somewhere between 60 and 70 cases showed that a 40% survival rate was being achieved.

Now, this is a pretty extensive operation, and it was done in the beginning only on the patient to whom we had nothing better to offer, such as the patient with tumor invading bone or the patient who had had irradiation and then a recurrence. We are now employing these procedures more widely, and that figure of 40% will be revised upward.

Dr. Walter W. Carroll, Chicago: I should like to reiterate what Dr. Morfit has said; namely, we must realize that this combined operation first showed promise for patients who had recurrences after irradiation or who came to us with extensive primary involvement. In view of this salvage, one might consider whether or not we are withholding this operation from patients with smaller lesions who otherwise might be benefited.

# INTERNAL FIXATION OF JAW FRACTURES

## Further Report

FRANK McDOWELL, M.D.
AND
JAMES BARRETT BROWN, M.D.
ST. LOUIS

DIRECT, rigid fixation of the bone fragments is best in treating severe fractures of the jaws. This is accomplished by drilling one or more steel pins or Kirschner wires longitudinally through the bone across each fracture site to firmly engage both fragments. The resulting steel skeleton within the bone transforms a shattered, limp jaw into a solid unit and maintains its integrity until bony union has occurred and the pins can be removed (Fig. 1).

The serious complications to be avoided in jaw fractures are osteomyelitis, nonunion, and malunion; all of them can be prevented by early accurate reduction and firm fixation. Wobbly fixation is no better in the jaws than in other fractures, and the end-results may even be worse. The rigidity of the internal fixation described here is due to the fact that the steel pins have such leverage advantage that the bone ends cannot move unless they first shear the metal in two, and this they cannot do.

Wide open operation is seldom desirable in jaw fractures because of blood-supply problems created and possible danger to branches of the facial nerve. Because of this, many distant and circuitous methods of fixation have been used in the past in which the bone fragments were attached indirectly to the opposite jaw or to a plaster headcap rather than to each other.

Fixation of mandibular fragments to the upper jaw by interdental wiring is still useful in simple fractures when the upper jaw is solid and when there are enough sound lower and upper teeth present on both sides of the fracture line. These prerequisites are not met in many fractures of the mandible, and when attempts are made to use this fixation without them failures will occur. These failures will not be avoided by trying to extend the method with complicated, expensive dental splints. Actually, the results may be worse if the jaw is left flopping for several days while such apparatus is being constructed and fitted.

Indirect fixation of the bones to a plaster headcap is cumbersome and insecure. The leverage is against the apparatus, with every small movement of the headcap or intermediaries being translated into a larger movement of the bones. Even if it were possible to prevent the headcap from moving on the scalp, there is no satisfactory method to prevent the scalp from moving on the skull. This floating fixa-

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Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 29, 1951.

tion has resulted in many complications, which could have been prevented by early direct fixation of the bone ends to each other.

Various types of external bar fixation have similar disadvantages. The bone fragments have leverage advantage upon the apparatus, and each small movement within the apparatus allows a larger movement of the bone ends (Fig. 2).

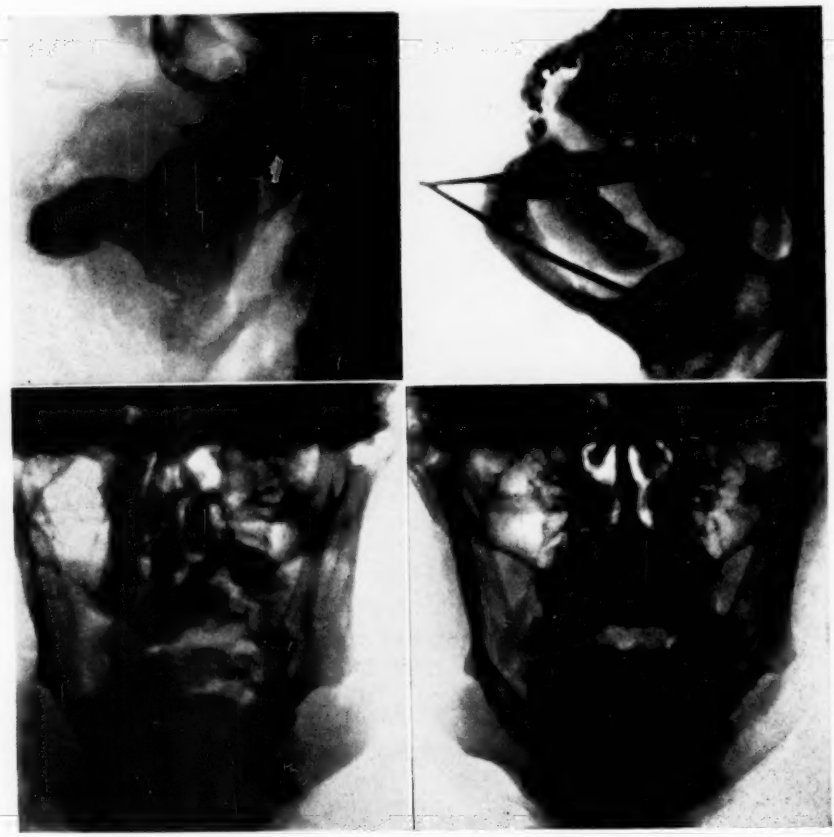

Fig. 1.—Side and front roentgenograms made before and after fixation of severe bilateral fracture of atrophic, edentulous mandible. Primary union obtained without bone grafting.

Direct internal fixation of the bone ends to each other with steel pins or Kirschner wires has yielded good results in many severe fractures, even in atrophic, "pipe-stem," edentulous mandibles with multiple fractures that could not have been completely immobilized in any other way. The incidence of secondary bone grafting has been cut down to almost zero.

Since the method was published by us in 1942 for use in jaw fractures, it has been widely adapted by others for use in other bones. This has confirmed its soundness, but the longest experience has been in treating jaw fractures. This

experience has proved the dependability of the method as the primary one to use in severe jaw fractures, and has shown that with careful application it will yield the best possible results.

### MANDIBULAR FRACTURES WITH EDENTULOUS FRAGMENTS

It seems obvious that a complete fracture in an edentulous jaw is not a dental problem (except for later construction or adjustment of dentures) and is not

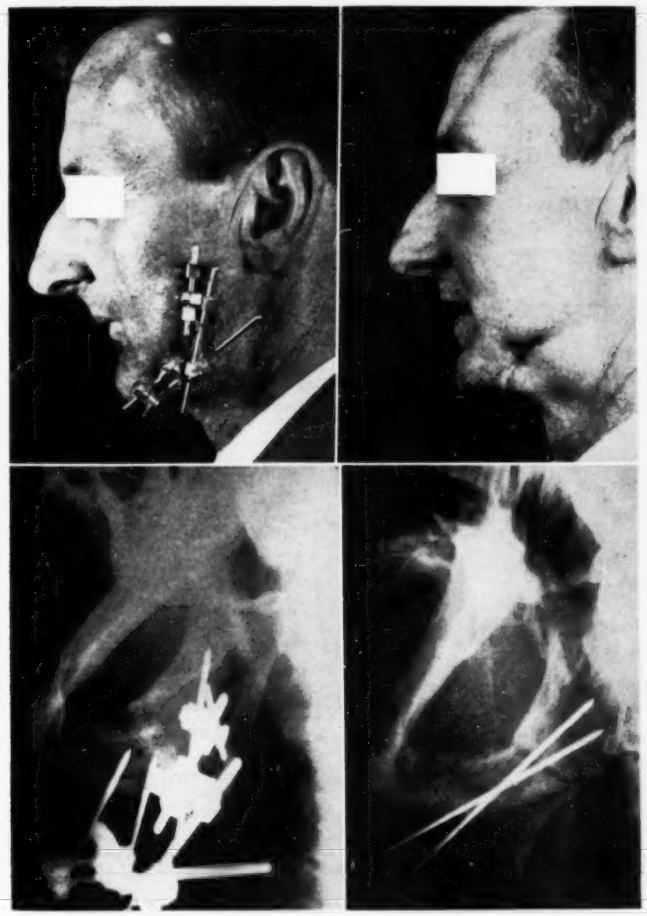

Fig. 2.—Photograph and roentgenogram at left show failure of external bar apparatus applied elsewhere. This was removed, the fracture was reduced, and two internal pins were drilled into place. Union was solid six weeks later.

amenable to dental fixation (Fig. 1). The internal fixation described here is practically a *sine qua non* for the best treatment of these fractures.

In occasional fractures in which the anterior fragment contains teeth and the posterior fragment is edentulous, union can be obtained by immobilizing the anterior fragment by interdental fixation and counting on the closing muscles to hold in

place the posterior fragment. This works best in incomplete fractures or in oblique situations where the closing muscles tend to lock the posterior fragment into place, but is generally unreliable. Though complications have been frequent in these fractures (particularly those in the angle region), they can be reduced to almost zero by the routine primary use of internal fixation to solidly connect both fragments. Here, as elsewhere in the body, the fracture does better if both fragments are controlled and held in rigid apposition (Figs. 3 and 4).

### MANDIBULAR FRACTURES WITH PARTIALLY EDENTULOUS UPPER JAWS

When the upper jaw is completely edentulous, it is again obvious that interdental fixation cannot be used to control a fracture of the lower jaw. The same

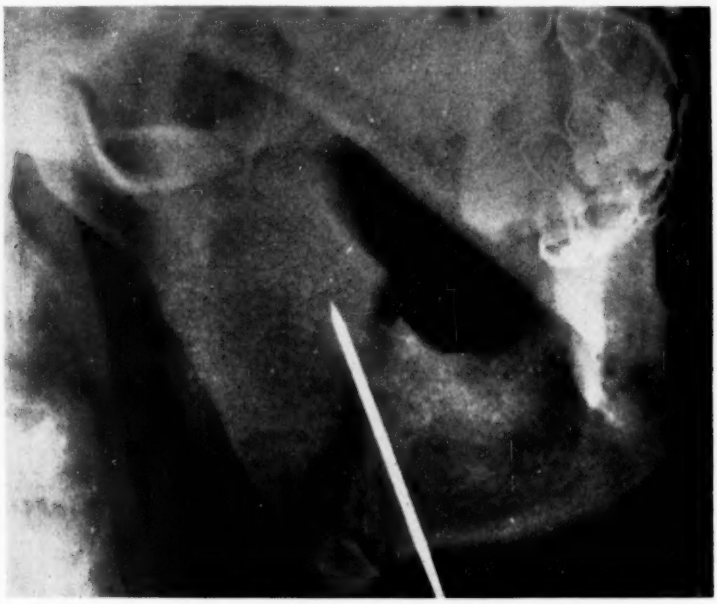

Fig. 3.—Fracture through ramus near angle successfully treated with one vertical pin.

considerations hold when the part of the upper jaw opposite the teeth in the posterior fragment is edentulous, or when the upper or lower teeth in this area are broken or loosened by trauma or pyorrhea. In all these situations, direct internal fixation of the bones is relied upon and any method of indirect dental fixation is uncertain or worse.

### SYMPHYSIS FRACTURES IN THE MANDIBLE

Nonunion and malunion are notoriously common in complete symphysis fractures which are treated by dental or other indirect fixation. This is because the powerful closing muscles pull the angles of the jaw outward each time they contract and produce a "rockering" motion of the bony ends at the fracture site. This occurs each time the patient swallows, whenever he clenches his jaws, and often during speech. Prevention requires a double plane of fixation at the symphysis.

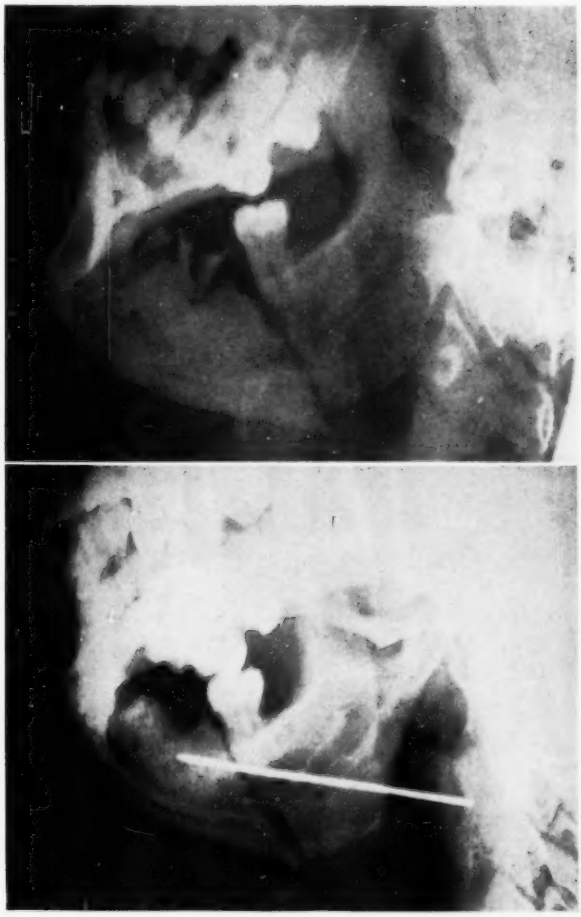

Fig. 4.—Fracture through third molar area successfully treated by drilling one pin forward from the back of the ramus. Carious root fragments of first and second molars removed at time of operation. Third molar roots in line of fracture; this tooth was removed later.

Fig. 5.—Symphysis fracture in edentulous mandible treated by drilling two pins across it for a double plane of fixation. Patient's dentures occlude well after treatment.

The lower plane is produced by a steel pin drilled across through the bones near the bottom of the jaw. The upper plane of fixation can be another steel pin drilled across at a higher level (Fig. 5), or a dental arch bar on the teeth when the situation is suitable (Fig. 6).

Fractures on either side of the symphysis but near it are also liable to this "rockering" motion and also require a double plane of fixation for solidity.

### JAW FRACTURES IN WHICH THE TEETH ARE DISEASED OR LOOSENED

In some jaw fractures which would otherwise be amenable to interdental fixation, some of the key teeth for fixation may be badly damaged by caries, covered by crowns or bridgework, broken, or loosened by trauma or pyorrhea. In these situations it is usually better to rely upon direct fixation of the bones with steel pins rather than upon any wobbly or uncertain dental fixation which might damage the teeth still further.

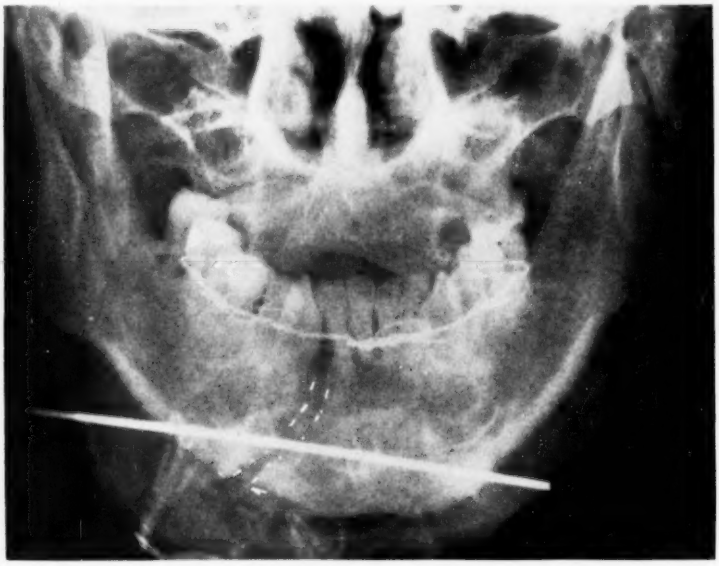

Fig. 6.—Symphysis fracture in patient with edentulous upper jaw. Double plane of fixation obtained by dental arch bar and internal pin.

### FRACTURES OF THE UPPER JAW

Much has been written about the transverse separation of the upper jaw from the bones of the face by a fracture just above the alveolus clear across the face. This fracture is rare, and when it occurs the jaw is often jammed upward rather than hanging down into the mouth as usually described. Treatment requires reduction first, then immobilization by interdental wiring when feasible, otherwise by direct wiring to the intact bones above.

More common is the vertical split through the hard palate which angles laterally farther up, coming out through the side of the antrum or going on up through the orbital floor. Treatment may consist of accurate reduction of the loose block, then

holding it in place with one hand while drilling a steel pin transversely through the middle third of the face just above the tooth roots, going through the detached block first and then across through the intact bone on the other side. This gives a cantilever type of fixation, which is very useful alone [1] or in conjunction with interdental fixation when the latter is applicable. If it is necessary to pack gauze into the

Fig. 7.—Severe double fracture near both mental foramina with many loose and damaged teeth above and below. Main fixation with two internal pins. Auxiliary fixation with lower dental arch bar and two interdental wires.

antrum to maintain its configuration or to hold the orbital floor up, the pack is put in first and the steel pin is then drilled in, going through bones, gauze, and all.

1. Brown, J. B.; Fryer, M. P., and McDowell, F.: Internal Wire-Pin Immobilization of Jaw Fractures, Plast. & Reconstruct. Surg. **4**:30-35 (Jan.) 1949; Internal Wire-Pin Stabilization for Middle Third Facial Fractures, Surg., Gynec. & Obst. **93**:676 (Dec.) 1951; Internal Wiring of Middle Third Facial Fractures, Plast. & Reconstruct. Surg. **9**:276 (March) 1952.

At times the above vertical split may connect with lateral fractures on both sides so that the upper jaw is in two and both blocks are loose. In this instance, fixing the two parts of the upper jaw to each other with one or more steel pins may be the first and most important step in the immobilization.

### FRACTURES OF THE MIDDLE THIRD OF THE FACE

In vertical splits through the middle third of the face, transverse steel pins may be useful as the primary method of fixation or as an adjunct to other fixation. No complications have been encountered from passing the pins through the maxillary antra with or without gauze packing placed therein.

### FRACTURES OF BOTH JAWS

In fractures of both jaws, as in fractures of either jaw alone, interdental wiring may be used as far as feasible to assure final occlusion of any serviceable teeth. However, internal steel pins are relied upon for the main fixation of the mandible. Once the mandible is solidified with steel pins, the upper jaw can be attached to it by interdental wiring if there are enough occluding teeth; otherwise, the upper jaw may be wired directly to the nearest solid bone above.

### COMMINUTED FRACTURES OF THE MANDIBLE

In comminuted fractures of the mandible, the major fragments can often be impaled on one or more steel pins to restore continuity and rigidity to the jaw. Wide open operations on these jaws are especially to be avoided because of danger of interfering with the blood supply to useful fragments (Fig. 7).

### OPERATIVE TECHNIQUE OF INTERNAL PIN FIXATION

The technique of internal pin fixation has changed little since it was first reported.[2] The pins used can be fairly heavy Kirschner wires, bicycle spokes, or other round stainless steel pins of similar size. A three-sided point seems to penetrate the bone more easily than a spade point.

Accurate reduction is an absolute prerequisite, as the positions of the bones cannot be changed after the pin is drilled through. Such reduction can be obtained by immediate manipulation, and there is little reason to wait for gradual reduction by traction or other means. Guides to reduction include the patient's own sensations, the occlusion of any remaining teeth, and sometimes visualization of the bone ends through a compound wound. At times it is useful to slip a Joseph elevator through a compound wound between the bone ends and lever them into place.

Under as good asepsis as possible, the pin is drilled longitudinally through the bone across the fracture site and well into the other fragment with an electric drill. A hand drill is not satisfactory because the necessary pressure tends to displace the fragments. The rotation speed of the power drill should be fast enough for easy penetration but not fast enough to produce heat necrosis of the bone.

Two surgeons are required, one to hold the fragments in apposition and one to drill the pin through. If enough opposing teeth are present, temporary inter-

2. Brown, J. B., and McDowell, F.: Internal Wire Fixation for Fractures of Jaw: Preliminary Report, Surg., Gynec. & Obst. **74**:227-230 (Feb.) 1942; Internal Wire Fixation of Jaw Fractures, with Note on External Bar Fixation, ibid. **75**:361-368 (Sept.) 1942.

dental wiring may be used to help hold one or both fragments in position. At times a better "line can be drawn" on the correct path for the pin if the surgeon holds the fracture site between the fingers and thumb of one hand and the power drill in the other hand. The pin seems to go naturally between the thumb and fingers of the holding hand, and not into them.

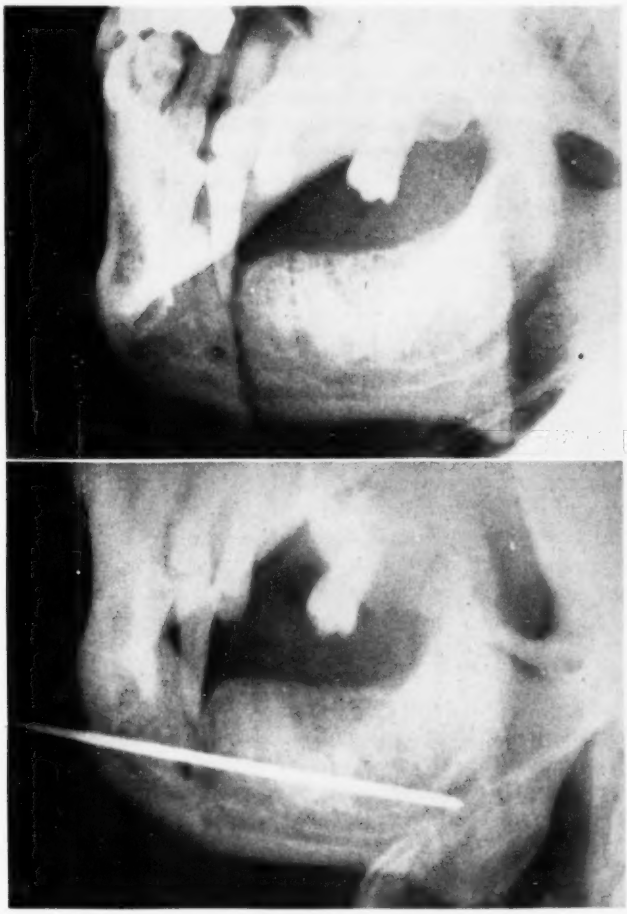

Fig. 8.—Fracture with long edentulous fragment. Successfully treated with one internal pin.

The pin is cut to minimal length to prevent "whipping" of it when drilling. The point is let in through a nick in the skin, pushed into the periosteum, and given a few slow turns to seat it in the bone. The drill is then lined up in the correct direction and the pin is drilled on through. The point may be brought on through the opposite cortex and skin, or it may be left buried in the bone if it seems solid enough. It is usually best to keep the pin below the nerve canal, though this is not so important in edentulous jaws or fragments. It is important not to

have the pin so low that it will tend to chip off the lower cortex. A fixation pressure dressing of surgical waste is a further support to the broken jaw and helps prevent hematomas and swelling of the soft tissues, thus decreasing chance of infection and adding to the patient's comfort. Antibiotics are used routinely for a few days after operation.

Various types of anesthesia may be used. There is no sensation within the bone unless the pin gets too close to the nerve canal, but local infiltration of the skin and periosteum at the points of entrance and exit may be required. Deep blocks of the third or second divisions may be used, or blocks of the more peripheral branches. A few minutes of intravenous thiopental sodium (pentothal sodium®) anesthesia at the actual time of drilling is often helpful.

Complications following the use of the internal fixation have been slight, confined for the most part to slight drainage around the wires.

Pins can usually be removed in from four to six weeks from the ramus and angle area, and in from six to eight weeks from the more anterior fractures. In some comminuted fractures in tiny atrophic jaws, up to 12 weeks' fixation may be necessary before the callus is solid enough to hold.

The internal fixation can be used in conjunction with any other type of fixation, but usually no other fixation is required.

In fractures of the body of the mandible at or in front of the second molar area, it is usually best to start the pin anteriorly and drill backward (Fig. 8). This anterior point must be in front of the curve of the jaw, and is frequently at the side of the chin. In fractures back of the second molar area, the pin is started on the back of the ramus just above the angle and drilled forward (Fig. 4). This back edge of the ramus is thin, but the point of the pin can be first engaged by a few slow turns on it before the drilling is started; it is necessary for someone to retract the ear lobe up out of the way and to hold the head turned toward the opposite side. In fractures at the back of the angle or in the lower ramus, it may be necessary to start the pin on the bottom of the jaw in front of the angle and then drill upwards into the ramus, taking care not to get the point up as far as the sigmoid notch (Fig. 3).

## SUMMARY

The internal wire-pin fixation described here has been used routinely for 12 years on our service for the treatment of many severe jaw fractures with excellent results. Firm union has been obtained in some of the most difficult situations. Secondary operations and bone grafting have been reduced to almost zero.

# CARDIOVASCULAR RESPONSES TO ACUTE LIGATION OF PORTAL VEIN

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AND
ROBERT F. GROVER, Ph.D.
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THE PRESENT study is the outgrowth of attempts to produce a form of portal hypertension in the dog which is consistent with that seen in man. It was observed that chronic occlusion of the portal vein in the dog did not result in a consistent elevation of the portal venous pressure. These initial studies were made in unanesthetized animals with pressures taken through a No. 19 needle inserted via a previously placed London cannula. It was found that nearly complete occlusion was required before a significant elevation of portal pressure could be produced in the acute preparation. Gradual occlusion over a two- to three-week period stimulated sufficient collateral circulation to allow complete occlusion without death of the animal. These studies were confirmed in the report before this meeting last year by Douglass, Mehn, Lounsbury, Swigert, and Tanturi.[1] They have recently been again confirmed by Morris and Miller.[2]

Since chronic occlusion of the portal vein does not produce a consistent elevation of portal pressure, we decided to investigate further the reasons for death after acute ligation. Our efforts in this regard were given impetus by the report of Child, Milnes, Holswade, and Gore,[3] showing that sudden complete occlusion of the portal vein in the Macacus rhesus monkey is unassociated with any untoward effects, although there is an immediate marked rise in portal pressure, which returns to normal in 7 to 10 days.

Initial observations in the dog showed that portal pressure rose abruptly after occlusion of the portal vein and that it remained elevated until the diastolic level of an associated fall in systemic arterial pressure was approximated (Fig. 1). Subsequently the arterial and portal pressures declined together until death occurred. It was further observed that the fall in arterial pressure appeared to have two components: (1) an initial abrupt fall occurring within 30 seconds after occlusion, and (2) a secondary gradual decline which led to death within an average of approximately one hour. On the other hand, it was observed that occlusion of the

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Read at the Fifty-Ninth Annual Session of the Western Surgical Association, Colorado Springs, Colo., Nov. 30, 1951.

From the Departments of Surgery and Physiology, and the Halsted Surgical Laboratory, of the University of Colorado Medical Center.

1. Douglass, T. C.; Mehn, W. H.; Lounsbury, B. F.; Swigert, L. L., and Tanturi, C. A.: Attempts at the Experimental Production of Portal Hypertension, Arch. Surg. **62**:785, 1951.

2. Morris, A. N., and Miller, H. H.: Chronic Portal Vein Occlusion and Portal Hypertension in the Dog, Surg. **30**:768, 1951.

3. Child, C. G.; Milnes, R. F.; Holswade, G. R., and Gore, A. L.: Sudden and Complete Occlusion of the Portal Vein in the Macaca Mulatta Monkey, Ann. Surg. **132**:475, 1950.

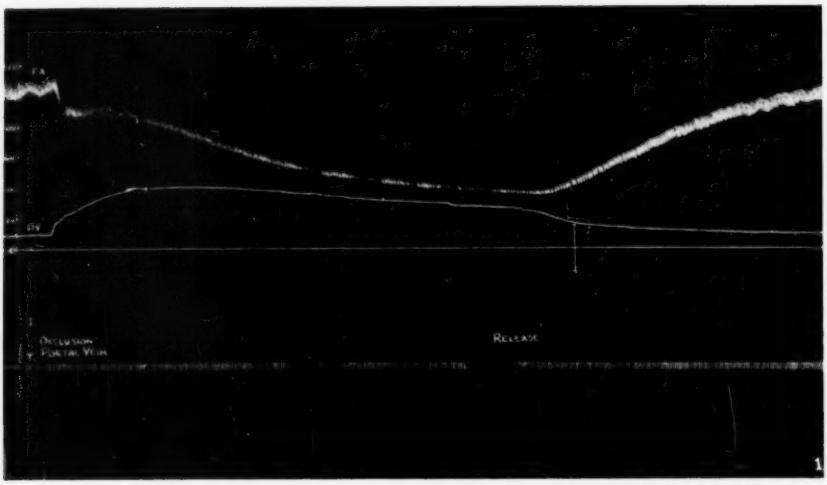



Fig. 1.—Kymographic record illustrating the effect of acute portal occlusion at the hilus of the liver on femoral artery pressure (*F.A.*) in the dog. *P.V.* indicates portal vein pressure; *I*, indicator marks; *T*, time (2-second intervals).

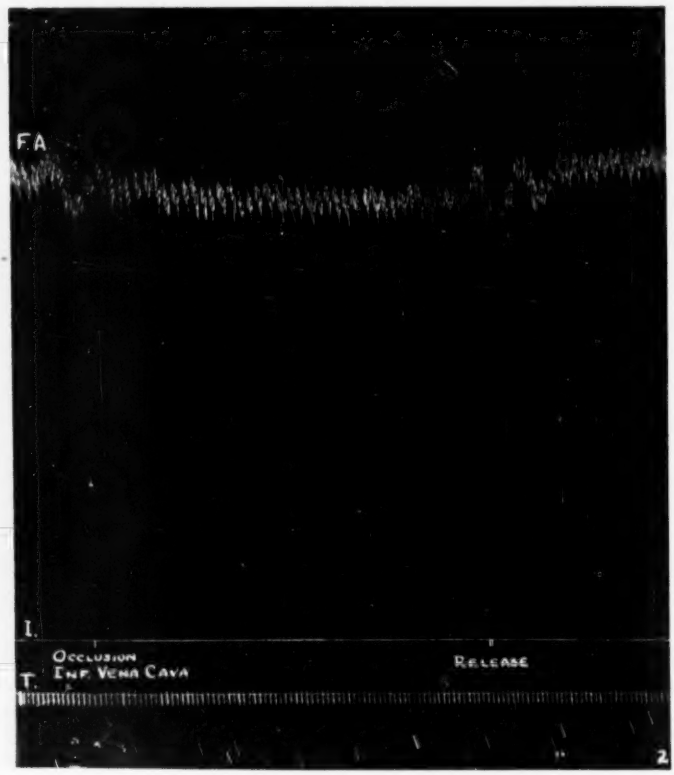



Fig. 2.—Kymographic record illustrating the effect of acute occlusion of the inferior vena cava between the entrance of the hepatic and renal veins on femoral artery pressure in the dog. *F.A.* indicates femoral artery pressure.

vena cava between the entrance of the renal veins and the hepatic veins did not result in any immediate, sustained fall in arterial pressure (Fig. 2). These observations suggested that some factor other than loss of circulating blood volume might play a part in the death which occurs after acute portal ligation. It was felt that if the initial fall could be overcome, the survival time in these animals might be significantly prolonged. A series of experiments have therefore been carried out over the past two years to determine the underlying physiological mechanism which provokes these changes in arterial pressure. The investigations fell naturally into the study of three possible mechanisms: neurogenic, mechanical, and humoral.

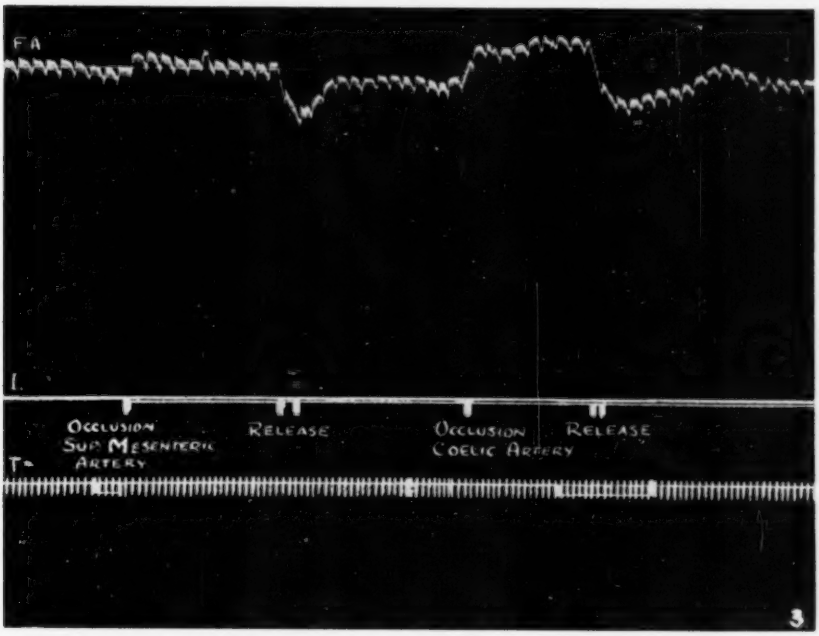



Fig. 3.—Kymographic record illustrating the effect of acute occlusion of the superior mesenteric and of the celiac arteries, at their origin from the aorta, on the femoral artery pressure (*F.A.*) in the dog.

The neurogenic possibility was investigated first, since Gammon and Bronk had found suggestive evidence to support the idea that a cardiovascular reflex existed in the mesenteric area.[4] They recorded afferent impulses traveling over the splanchnic nerves or their terminal branches along the mesenteric arteries and found that increases in blood volume caused an increase in the number of impulses transmitted. On the other hand, an increase in blood pressure resulting from an injection of epinephrine caused a decrease in the number of impulses. We therefore occluded the superior mesenteric artery and found that there was an immediate rise in the systemic arterial pressure (Fig. 3). A similar response

4. Gammon, G. D., and Bronk, D. W.: Pacinian Corpuscles in the Mesentery and Their Relation to the Vascular System, Proc. Soc. Exper. Biol. & Med. **31**:788, 1934.

could be obtained by occluding the celiac axis, and the two effects were additive. That this arterial response is a true reflex is shown by the fact that procaine injection around the base of the superior mesenteric artery and celiac axis blocked the blood pressure elevation (Fig. 4). Such injection did not, however, alter in any way the typical response to acute portal vein occlusion. Even a two-stage bilateral transthoracic sympathectomy and splanchnicectomy, removing the chain from the fifth thoracic through the second lumbar segment, failed to block this response to portal occlusion. Similar results were obtained following transthoracic vagectomy. Moreover, attempts to stimulate the portal vein directly, utilizing a Faradic current, did not cause any change in the systemic arterial pressure. We

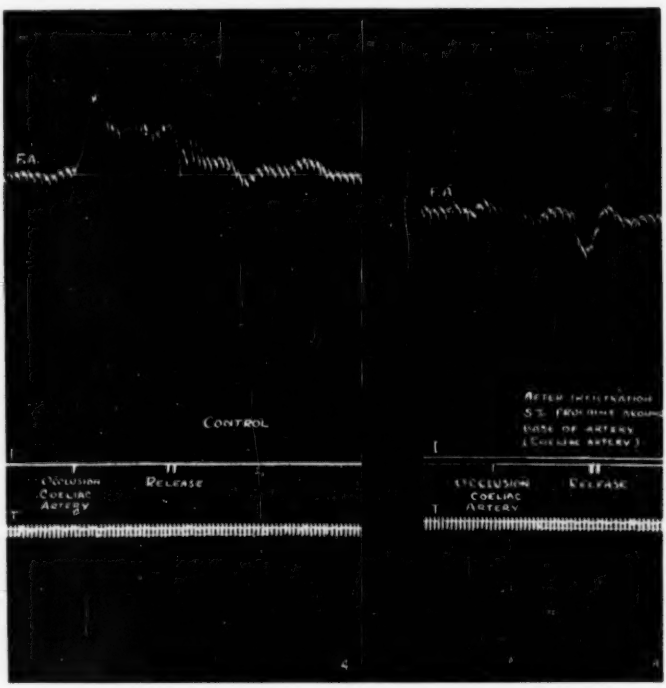



Fig. 4.—Kymographic records illustrating the effect of occlusion of the celiac artery on the femoral artery pressure (*F.A.*) of the dog, both before and after procaine infiltration around the celiac axis.

therefore placed a T-tube in the portal vein and injected rapidly a controlled volume of blood or saline, with the pressure recorded. On the basis of the observations of Gammon and Bronk, one would have expected that this method for elevating portal pressure might cause a fall in arterial blood pressure. Nevertheless, contrary to all expectations, the blood pressure rose after the rapid injection of 100 cc. of fluid (Fig. 5*A*). In order to overcome the possibility that this fluid was lost immediately to the liver bed, we partially constricted the portal vein to that point just above which a fall in blood pressure was not obtained. Again a rapid injection of saline was carried out, and again we obtained the same rise in blood pressure. It would

seem, therefore, that if the initial fall in blood pressure seen with acute portal occlusion is due to a neurogenic reaction, the neural pathway is not via the mesenteric plexus.

Since it has always been assumed that the cause of death from acute portal vein ligation is a mechanical one, involving loss of blood volume by exsanguination

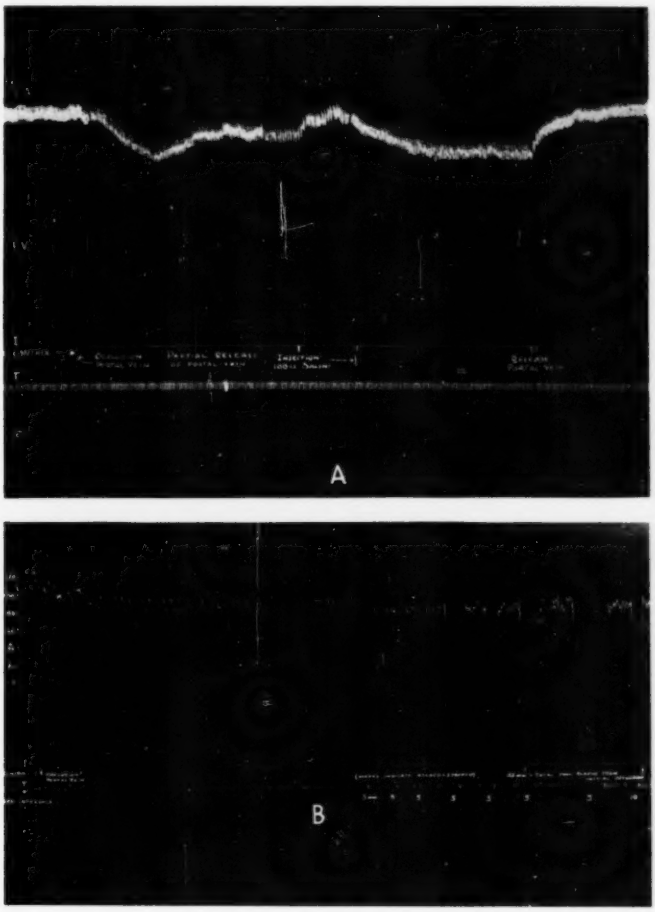



Fig. 5.—*A*, kymographic record of the femoral artery pressure (*F.A.*) and the portal vein pressure (*P.V.*) in the dog during partial occlusion of the portal vein. Secondarily 100 cc. of isotonic sodium chloride solution was injected in one minute into the partially occluded vein. *B*, kymographic record of the femoral artery pressure in the dog during acute occlusion of the portal vein. This record was made after resection of the bowel from the mid-duodenum to the mid-descending-colon. The total time elapsed from the initial occlusion is equal to 55 minutes. The latent blood pressure decline observed in control animals is not apparent.

into the portal bed, a series of experiments was carried out to determine what relationship this factor plays to these cardiovascular responses. Initially animals were treated by the simple process of transfusion. By this means the life of animals

could be prolonged four to five hours, with temporary small increases in blood pressure during the time of rapid transfusion. It would appear, therefore, that at least the latent manifestations of the arterial blood pressure changes are due to blood volume loss. This assumption was further confirmed by the fact that, after resection of the bowel from the mid-duodenum to the mid-descending-colon, we still obtained the initial acute fall on portal occlusion but did not obtain the prolonged latent blood pressure decline (Fig. 5*B*).

Confirmation of this fact was also obtained by establishing an external shunt from the portal vein to the femoral vein (Fig. 6), although mechanical factors involved in such a shunt were thought to account for some conflicting information obtained from this experiment. For example, the fall in arterial pressure continued after occlusion of the portal vein and opening of the portal-femoral venous shunt. On the other hand, removal of 100 cc. of blood from the portal vein in one minute

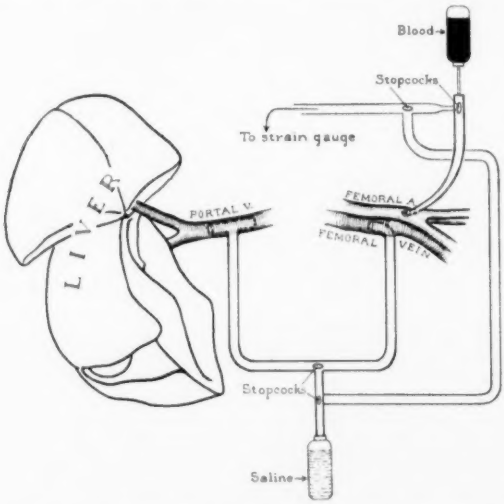



Fig. 6.—Diagram illustrating the method used in creating an external shunt from the portal vein to the femoral vein while recording the femoral artery pressure via the strain gauge. Mechanical factors interfere with observations made by this method.

caused a fall in femoral arterial pressure of the same magnitude as the rise in pressure obtained by injection of 100 cc. of saline solution into the femoral vein.

Consequently, it was felt that more accurate information could be obtained by a study of the cardiovascular dynamics when a portacaval venous shunt was present. Such an experiment might, in addition, tell us whether the initial fall, which seemed to be consistent in all instances, had any relationship to blood flow through the liver. The results of these experiments can best be understood by reference to the following diagram of the procedure (Fig. 7). First, let us consider the situation with the shunt closed. Under such conditions occlusion at either *A* or *C* causes the same picture, i. e., an initial fall followed by a prolonged slow decline in arterial pressure. On the other hand, occlusion at *B* causes essentially no change in systemic blood pressure. Now let us consider this situation when the shunt is open. Under these conditions occlusion at *A* produces no change in systemic blood pressure.

Occlusion at *B*, however, results in an elevation of portal pressure and a slight fall in arterial pressure. *A* and *B* closed together produce a fall in systemic arterial pressure almost identical with that observed when *C* is occluded alone.

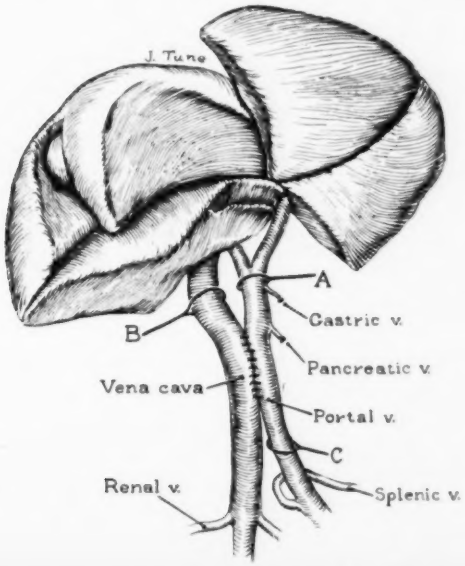
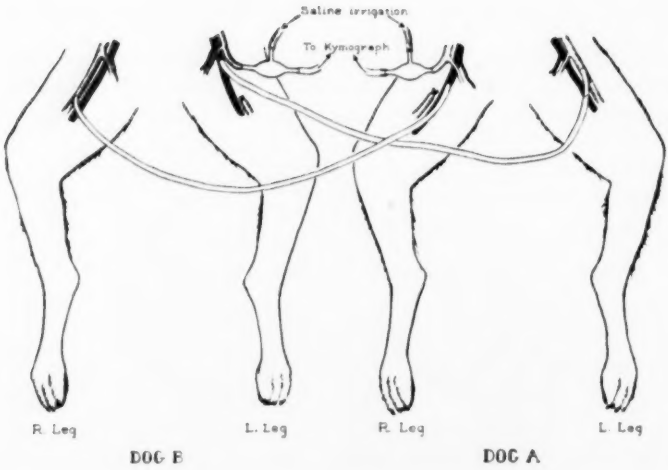


Fig. 7.—Diagram illustrating the portacaval shunt created in the dog and the location of the various ligatures which were temporarily occluded. The kymographic record show the femoral artery pressure (*F.A.*) during occlusion at the various sites as indicated.

The results of these experiments lead us to the following conclusions: 1. Failure of portal blood to flow through the liver does not affect blood pressure. 2. It would seem that blood volume changes are not the sole contributing factor to the



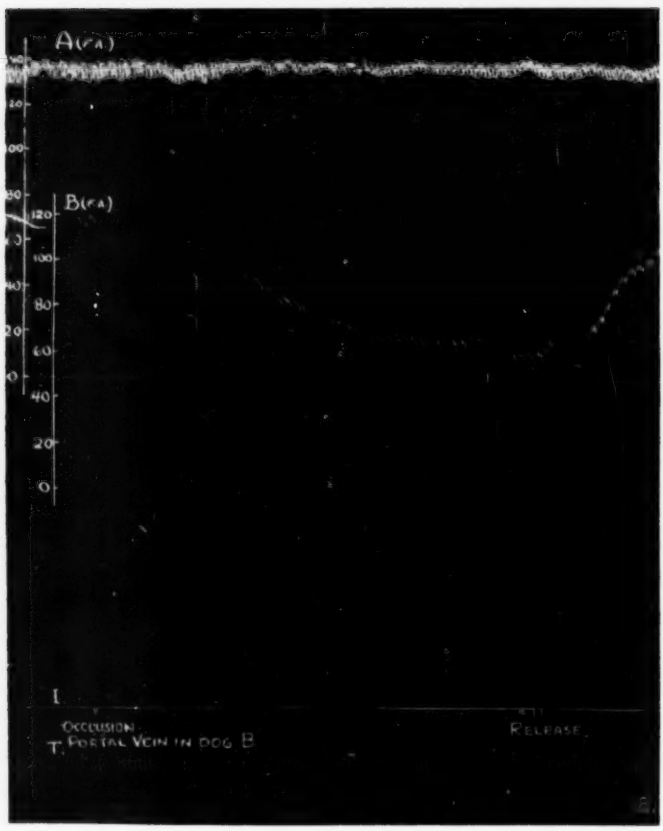




Fig. 8.—Cross-circulation experiment. Diagram of the procedure and kymographic record of the femoral artery pressures (*F.A.*) in the donor (*B*) and the recipient (*A*) animal. The portal vein was occluded in the donor (*B*) animal.

initial fall in blood pressure observed after acute portal occlusion. 3. The factor responsible for this fall in arterial pressure is apparently initiated by receptors present in the splanchnic mesentery. 4. The responses observed could be on a humoral basis, because of the previous experiments showing that mechanical or neurogenic factors are probably not involved.

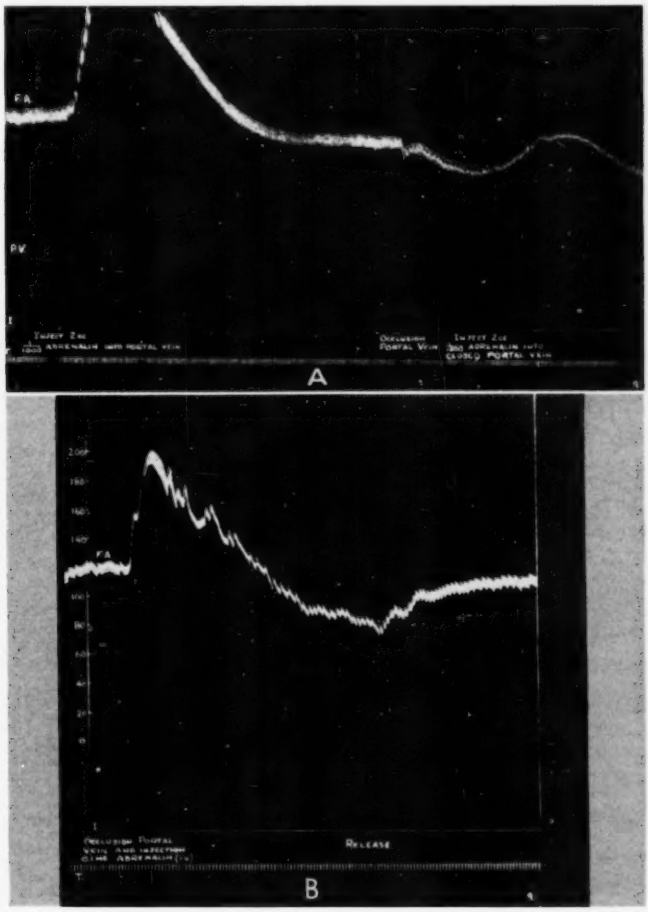



Fig. 9.—*A*, kymographic record illustrating the effect of epinephrine, injected into the portal vein, on femoral arterial pressure (*F.A.*) and portal vein pressure (*P.V.*) in the dog. The initial injection was made into the unoccluded vein. The second injection was made after portal occlusion. *B*, epinephrine injected into the peripheral venous system at the time of portal occlusion will mask the initial fall in femoral artery pressure.

The necessity for proof of the humoral relationship to blood pressure required a third set of experiments, the first of which involved cross circulation with careful recording of blood pressure changes in the femoral arteries of both dogs (Fig. 8). The accompanying kymographic tracing shows that there was no effect on the

blood pressure of the recipient animal. There are, however, certain inherent difficulties with cross-transfusion experiments, as a result of which others who have had more experience in this regard than we have come to place very little faith in negative results. Other methods were therefore employed.

The apparently complete absence of compensation on the part of the cardiovascular system to the initial fall in blood pressure, i. e., neither an increase in pulse

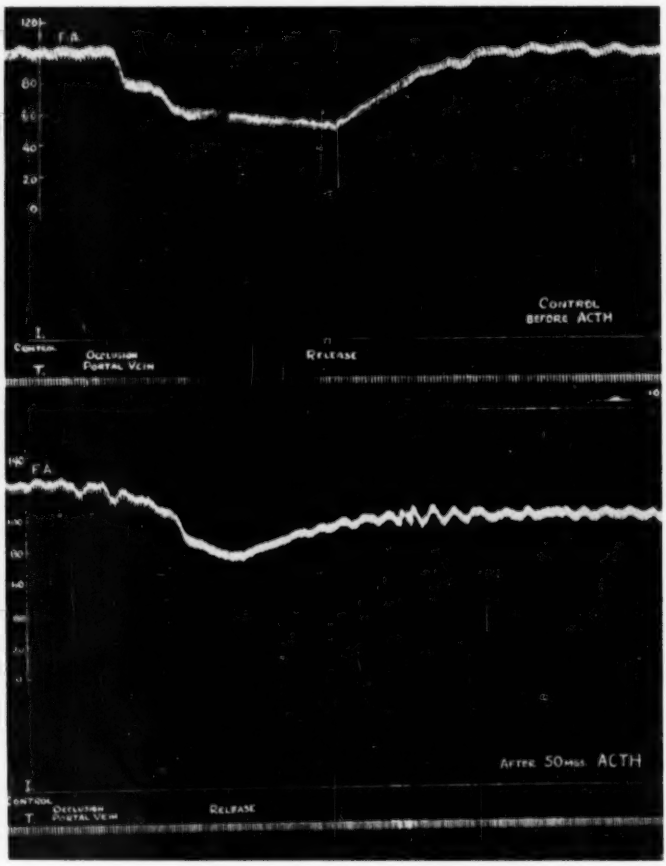



Fig. 10.—Kymographic record of the blood pressure response in the femoral artery (*F.A.*) of the dog following acute portal vein occlusion, both before and after administration of 50 mg. of corticotropin (given in 500 cc. of isotonic sodium chloride solution over a six-hour period). The initial fall in arterial blood pressure is not observed following the administration of corticotropin.

rate nor a peripheral vasoconstriction, suggested a failure of the adrenal gland to respond to this initial stress. Therefore, our efforts were directed toward augmenting the normal adrenal response. Epinephrine given intravenously, augmenting the response of the adrenal medulla, was found to restore temporarily a blood

pressure which had previously been lowered by portal vein occlusion. Further, epinephrine given immediately prior to portal occlusion will mask the initial abrupt fall in blood pressure (Fig. 9). In either case, however, the epinephrine effect is only transient. This would perhaps be expected, since epinephrine acts predominantly at the hepatic end of the portal system rather than on the arteries supplying this system.[5]

We then attempted to augment the adrenal cortex factors by giving an animal 50 mg. of corticotropin (ACTH)[6] in 500 cc. of isotonic sodium chloride solution (containing 4 cc. of heparin sodium) intravenously over a six hour period. When the portal vein was subsequently occluded, we were unable to obtain the initial fall

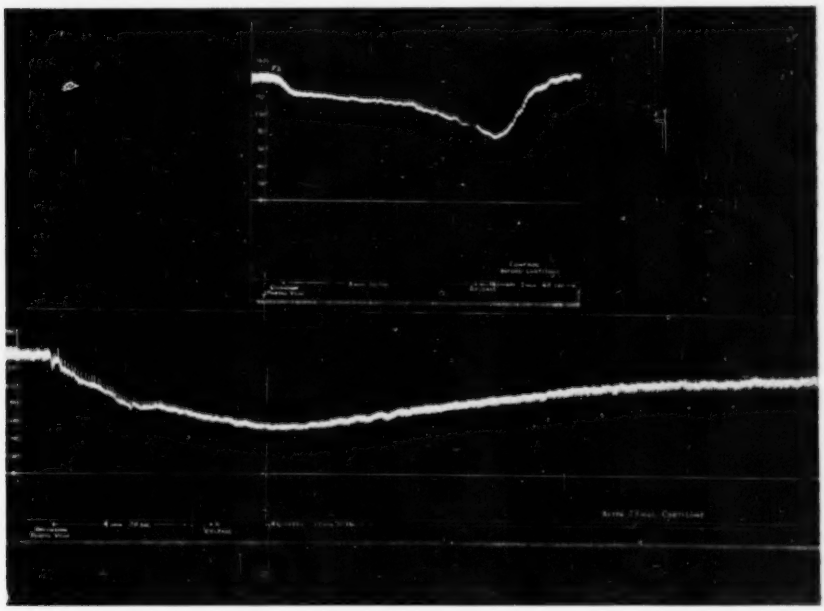


Fig. 11.—Kymographic record of femoral artery pressures (*F.A.*) in the dog before and one-half hour after the intragastric administration of 25 mg. of cortisone. It will be observed that the portal vein was occluded 5 minutes 20 seconds during the control period. Subsequently, the animal's blood pressure returned to normal in 2 minutes 40 seconds. After the administration of cortisone the portal vein was occluded only 4 minutes 20 seconds, but it took 17 minutes 20 seconds for the blood pressure to reach the control level.

which was originally observed (Fig. 10). Since corticotropin may act independently, as well as through the adrenal cortex, we attempted to separate these two factors. The adrenal action was supplemented by the giving of 25 mg. of cortisone through a gastric tube to two animals. It can be seen from the kymographic record-

5. Katz, L. N., and Rodbard, S.: The Integration of the Vasomotor Responses in the Liver with Those in Other Systemic Vessels, J. Pharmacol. & Exper. Therap. **67**:407, 1939.

6. The corticotropin (ACTH) utilized in these experiments was supplied through the courtesy of Armour Laboratories, Chicago.

ing taken one-half hour later that the ability of the animal to adjust to portal occlusion is, if anything, impaired after the administration of cortisone (Fig. 11).

Corticotropin could act directly upon the splanchnic mesentery or indirectly by suppressing the activity of the anterior pituitary. Vasopressin (surgical pituitrin; pitressin®) is known to constrict the splanchnic arteries delivering blood to the portal system. Initial experiments suggest that vasopressin may eliminate the initial blood pressure response to portal occlusion, but oxytocin (pitocin®) has no such action. This blocking action indicates, therefore, a relationship to the hypertensive factor in pituitary extract.

## COMMENT

The consequences of these experiments are of interest from a number of viewpoints. Especially stimulating is the consideration that previous factors relative to hypertension, and thought to be existent in the liver, may actually originate in the splanchnic mesentery. Davis and Tanturi have recently reported that partial occlusion of the portal vein in an animal made hypertensive by the Goldblatt method will result in a lowering of the blood pressure.[7] They have observed that the occlusion must be sufficient to result in fatty degeneration of the liver if the blood-pressure effect is to persist. It would seem from our observations that blood flow through the liver is not a factor in blood-pressure changes systemically but that some other factor, influenced by the anterior pituitary and originating within the splanchnic mesentery, may be the significant principle. We have begun investigations to answer this question.

The possibility that we have been dealing with a previously undescribed reflex of a humoral nature is intriguing. A portal-bed hepatic-venous reflex has been suspected before. Burton-Opitz in 1911 observed that stimulation of the hepatic plexus caused an increase in blood outflow from the liver.[8] It was assumed that the stimulation acted upon a hepatic venous sphincter, sometimes described by others as a "variable sluice mechanism."[9] If epinephrine was injected, the effect was reversed in that hepatic outflow was decreased. When epinephrine was injected and the hepatic plexus also stimulated, no change occurred in the hepatic outflow. Similarly, occlusion of the hepatic outflow and stimulation of the hepatic plexus did not cause any increase in venous outflow. It would seem, therefore, that the hepatic artery has the ability to increase the volume of blood it carries to the liver.

Schwiegk subsequently confirmed this supposition by demonstrating an inverse relationship between the ability of the hepatic artery and the portal vein to increase their volume of flow.[10] In the presence of portal occlusion the hepatic artery blood flow increased 50 to 100%. Epinephrine and pituitary extract both caused a similar increase in arterial inflow but at the same time caused a decrease in portal flow. Pituitary extract was also found to have the interesting faculty of causing a decrease in the blood flow through all arteries of the body, with the exception of the hepatic.

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7. Davis, L., and Tanturi, C. A.: Liver as a Factor in Expermental Renal Hypertension, Arch. Surg. **62**:325, 1951.

8. Burton-Opitz, R.: The Vascularity of the Liver: IV. The Magnitude of the Portal Inflow, Quart. J. Exper. Physiol. **4**:113, 1911.

9. Lichtman, S. S.: Diseases of the Liver, Ed. 2, Philadelphia, Lea & Febiger, 1949, pp. 40-42.

10. Schwiegk, H.: Untersuchungen über die Leberdurchblutung und den Pfortaderkreislauf, Arch. exper. Path. u. Pharmacol. **168**:693, 1932.

As a result of these observations, it would seem highly improbable that occlusion of the portal vein alone could, on a purely mechanical basis, result in the initial fall in blood pressure observed (Table). It has been variously estimated that the blood flow from the hepatic veins is from 85 to 100 cc. per minute per 100 gm. of liver tissue. In the dog the liver accounts for about 3% of body weight.[11] This means that the blood flow through the liver in a 10 kg. dog approximates 300 cc. per minute. It has also been estimated that the hepatic arterial flow is about 20 to 25% of total blood flow through the liver,[12] or, in the case of a 10 kg. dog, approximately 75 cc. per minute. On the basis of the work of Schwiegk, this arterial flow should equal about 150 cc. per minute in the face of portal occlusion. The blood volume of the dog is reported as approximating 100 cc. per kilogram, or, in a 10 kg. dog, 1,000 cc.[13] Hence, portal occlusion for one minute would remove about 15%, or one-seventh, of the blood volume. The response we observed occurs in less than half that time.

*Statistics Utilized in Evaluating Mechanical Relationships of Blood Volume Flow to Changes in Arterial Pressure in the Dog*

| | |
|---|---|
| Liver blood flow | = 100 cc./min./100 gm. of liver tissue |
| Liver weight | = 3% of total body weight |
| ∴ Liver blood flow | = 300 cc./min. in 10 kg. dog |
| Hepatic artery flow | = 25% of liver blood flow |
| ∴ Hepatic artery flow | = 75 cc./ min. |
| with portal vein occluded | = 150 cc./min. (Schwiegk) |
| Blood volume | = 100 cc./kg. |
| ∴ Blood volume in 10 kg. dog | 1,000 cc. |
| Renal blood flow | = 20% (1/5) of average cardiac output |
| Portal blood flow | = 4/5 of total renal blood flow |

We have also shown that occlusion of the vena cava between the renal and hepatic veins does not have any initial sustained effect on arterial blood pressure. We have been unable to find any measurement of total vena caval blood flow below the entrance of the hepatic veins, but it is reported that portal blood flow is about four-fifths of total renal flow.[14] Hence, it is impossible to conceive of the failure of vena caval obstruction above the renals to produce a fall in blood pressure, if mechanical factors were to be credited with causing the initial fall in blood pressure observed with portal occlusion.

The solution to this problem would be simplified if a distinct nerve pathway for the transmission of this reflex could be demonstrated. However, it appears more reasonable to believe there is some other method by which this response is mediated. The evidence presented would indicate that a presently undefined relationship exists with the anterior pituitary. It would seem that the adrenal cortex is not involved; at least, factors present in cortical extracts now available do not favorably

11. Sisson, S.: The Anatomy of the Domestic Animals, revised by J. D. Grossman, Ed. 3, Philadelphia, W. B. Saunders Company, 1938, p. 512.

12. Best, C. H., and Taylor, N. B.: Physiological Basis of Medical Practice, Ed. 4, Baltimore, Williams & Wilkins Company, 1945, p. 286.

13. Huey, D. M.: Plasma Volume Studies with T-1824, Thesis, University of Colorado, 1948.

14. Medical Physics, edited by O. Glasser, Chicago, Year Book Publishers, Inc., 1950, Vol. 2, p. 244.

influence the response. Epinephrine from the adrenal medulla does not appear to produce this reaction. If there is any relationship between corticotropin and the adrenal medulla, it must be depressant by counteracting a normal stress response of the body. The fact that vasopressin may prevent this fall in blood pressure is intriguing but needs further confirmation at this time.

## CONCLUSIONS

1. Gradual occlusion of the portal vein in the dog over a two- to three-week period does not result in a significant elevation of portal pressure.

2. Acute complete occlusion of the portal vein causes an immediate fall in systemic arterial pressure, which is followed by a secondary gradual decline leading to death in about one hour.

3. Sudden complete occlusion of the superior mesenteric and celiac arteries causes an immediate rise in systemic arterial pressure, which appears to be a true neurogenic reflex mediated over the splanchnic nerves.

4. The initial fall in arterial pressure following sudden complete occlusion of the portal vein appears to be reflex in nature, while the secondary fall is apparently due to blood volume changes.

5. The secondary fall can be prevented by removal of the bowel from the mid-duodenum to the mid-descending-colon, but the initial fall remains unaffected.

6. A study of cardiovascular responses following acute portal occlusion in the presence of a portacaval shunt leads to the impression that the stimulus for the initial fall in arterial blood pressure originates in the splanchnic mesentery and not in the liver.

7. The initial fall in arterial blood pressure following acute portal vein occlusion can be temporarily blocked by corticotropin (ACTH) but not by cortisone.

## DISCUSSION

DR. JACOB K. BERMAN, Indianapolis: I had the privilege of seeing some of Dr. Peck's experiments in progress last September. I was very much impressed, not only with the work he was doing but with the manner in which he was doing it. I talked to him at some length about the portal bed-hepatic reflex at that time, and, in addition, I had the extreme pleasure of reading his paper about a week ago.

It would seem that the principal finding in all his experiments is the inverse variance of pressure between the portal vein and the femoral artery. In each instance of a portal increase there occurred within 30 seconds a sudden fall in arterial pressure as recorded in the femoral artery. This reflex has been suspected for some time, but it has not been demonstrated previously as clearly as the present authors have done. However, one of their findings is surprising. When they injected 100 cc. of saline solution into the portal vein they did not cause the sudden fall, but, on the contrary, a rise, in arterial pressure. This is certainly not what we should expect. However, there is a difference between the injection of fluid into the portal vein and its infiltration peripherally into the capillary bed. The build-up of pressure is slower and occurs cephalad rather than caudad. Perhaps the direction of the increase in pressure and the time factor may be important variants.

The immediate fall in arterial pressure which occurs within 30 seconds is followed by gradual decline until the death of the animal. This primary fall follows a sudden increase in pressure within the portal bed and therefore is a reaction which probably originates in the splanchnic area. The secondary fall is due to the decrease in circulating blood volume, due, in all probability, to the entrapment of blood in the portal system. The problem is related to

clinical observations of a sudden fall in blood pressure when intra-abdominal tension is suddenly reduced, as occurs after rapid paracentesis or the removal of a large pelvic tumor, or immediately after Caesarean section. We have frequently seen such phenomena, even though a high spinal anesthetic had been given. This would indicate that the portal bed-hepatic reflex is not neurogenic.

The implications of this study are very important because they may lead to the development of methods permitting the safe removal, through temporary interference with the blood supply, of vital organs, large tumors or cysts, or encapsulated masses without the dangers of a sudden hypotension.

We have been studying the prolonged portal bed-hepatic reflex in normotensive, hypertensive, and cirrhotic dogs during the past five years. The only animals showing a persistent fall in blood pressure were hypertensive dogs in which the inferior vena cava had been incompletely ligated with a polyethylene polythene® band just above the diaphragm. This procedure resulted in a passive hyperemic cirrhosis with ascites. However, angiotonin unit studies in these animals disclosed no great variations. We believe that our observations have important clinical connotations, because the incidence of portal cirrhosis with portal hypertension and high blood pressure is extremely low. Is this phenomenon due to portal hypertension and the portal bed-hepatic reflex carried on over a long time or to the inability of the diseased liver to form the necessary substrate which combines with renin to produce hypertension, or angiotonin, or is it the result of the continuous plasmapheresis which occurs in cirrhotic animals and persons with ascites? There is no doubt that Drs. Peck and Grover have posed very stimulating questions as to the cause of this reflex in acute hypotension which is certainly associated with stimulation of the splanchnic mesentery.

Dr. William A. Altemeier, Cincinnati: This has been an exceedingly interesting paper to me. Dr. Fine, of Boston, has recently also reported some very interesting studies in severe shock produced by massive bleeding in dogs. With his method of extensive but controlled bleeding to produce shock, he found that the delayed transfusion of blood was followed by a prompt rise in pressure and a prolonged sustained secondary fall in pressure. The condition of shock thereby became irreversible and was fatal in 95% of the animals.

The irreversible state at first seemed to be associated with the growth of clostridial organisms normally present in the liver and tissues of the dog. However, the systemic administration of large amounts of penicillin or polyvalent specific antisera was followed by only limited survival of the animals. On the other hand, the oral administration of aureomycin prevented the secondary fall in blood pressure and permitted survival in 13 of 15 dogs. In addition, the removal of the intestine from the mid-duodenum to the mid-portion of the large intestine likewise prevented the secondary fall in blood pressure. Immunization of the dogs with Clostridium welchii toxoid, which my colleagues and I furnished Dr. Fine, had only a limited effect in preventing a secondary fall in systolic blood pressure.

The prevention of the irreversible state of shock by the oral administration of aureomycin or by the removal of the small intestine suggests that a toxin may be developed in the intestine, presumably by the intestinal bacteria, capable of producing the secondary and fatal fall in blood pressure.

I think that these two series of experiments are related and probably very significant.

Dr. Mordant E. Peck, Denver: I want to thank the discussers for their kind remarks. It was impossible, because of the time factor, for me to discuss all the ramifications of our investigations. I did not, therefore, attempt to discuss the relationship to the recent work of Friedman, Frank, and Fine. These workers have shown that in hemorrhagic shock there is an intrahepatic vasoconstriction with a resulting increase in portal pressure. The intrahepatic constriction has been shown to be neurogenically controlled. It is possible that this response is the initiating factor in a series of mechanisms terminating with death of the animal from circulating blood loss into the splanchnic bed. Dogs in hemorrhagic shock, having had bilateral adrenalectomy and hepatic denervation, stand only minimal blood loss, even though given adrenal cortex extract. This supports our observations that the ability of the animal to adjust to the

shock state is impaired by an excess of adrenal cortex factors alone. We feel that interference with portal outflow initiates a response which is the converse of all other known protective mechanisms of the body.

I might also add, in relation to Dr. Berman's remarks that we have made a very interesting observation. It has been stated that dogs will uniformly die if the inferior vena cava above the diaphragm is completely occluded for longer than 15 minutes, a procedure which obstructs the hepatic portal circulation. On the other hand, occlusion below the diaphragm for as long as 30 minutes does not lead to death of the animals. Dr. Owens, working in our laboratory, has confirmed this information. Utilizing our experimental data, he has now shown that dogs will survive a 20 minute occlusion of the inferior vena cava above the diaphragm if given corticotropin. Studies are in progress to determine how much this interval can be extended in order to facilitate organ transplantation.

# PHLEBECTOMY IN TREATMENT OF ACUTE THROMBOSIS OF SAPHENOUS VARICES OR VEINS

LOUIS G. HERRMANN, M.D.
CINCINNATI

WITHIN the past few decades fundamental research and clinical investigation have made available to the surgeon the necessary armamentarium with which to lessen the disability and often prevent the death of victims of traumatic shock, massive hemorrhage, or even rapidly spreading bacterial infection. Supportive treatment with whole blood, blood plasma, blood substitutes, and solutions of electrolytes, together with the judicious use of the proper antibiotic or chemotherapeutic agents, have reduced the mortality of even the most extensive surgical operations to a relatively low figure. Supportive measures have likewise enabled the extensively injured or the chronically ill patients to live longer and thus become ideal candidates for another of the great surgical scourges—namely, venous thrombosis and its dreaded consequence, pulmonary embolism.

For many decades venous thrombosis has been recognized as a common and often serious complication of chronic heart disease, debilitating illnesses, trauma, childbirth, and surgical operations. Recent surveys have shown a relative increase in the incidence of venous thrombosis in spite of the widespread interest in the problem and the many therapeutic measures which have been used to combat it or prevent its serious sequelae.

Venous thrombosis results from a variety of mechanisms which may operate at the same time and interdependently. There is no way of accurately determining in advance when or where venous thrombosis will take place in a given patient; consequently, many of our therapeutic measures are instituted after the process has become established. Anticoagulants are of importance as prophylactic agents against venous thrombosis, and they have also proved to be valuable in limiting the process of thrombosis. It must be emphasized, however, that the use of anticoagulants must be governed by regular and accurate laboratory studies upon the clotting mechanisms of the blood.

We believe that extension of the thrombosis or the fragmentation of the thrombus, with resulting pulmonary embolism, is related to alterations in the coagulability of the blood, as well as to the type of reaction in the wall of the vein where the blood clot exists. If the thrombus becomes adherent to the wall of the vein for only a few hours, permanent damage to the intima of the vein results. Small bits may break loose from the extending tail of the red thrombus when it builds up to the next proximal tributary where the blood stream exerts suction and torsion on the fragile clot, and pulmonary embolism takes place.

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Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 30, 1951.

From the Department of Surgery of the University of Cincinnati College of Medicine and the Lucie Rawson Laboratory for Vascular Research of the Cincinnati General Hospital.

The disabling late effects of venous thrombosis, such as chronic edema, indolent ulcers, chronic eczema, pigmentation, and induration of the skin of the legs, are responsible for serious economic loss to patients. Much has been written about these complications of deep venous thrombosis, and many medical and surgical measures have been used with varying degrees of clinical improvement. No single method has proved uniformly successful in all patients.

For years we have been interested in determining whether or not such blood clots contain bacteria. We have cultured thrombosed veins and clots from such veins but have not been able to recover pathogenic aerobic or anaerobic bacteria which could be shown to be the causative agents. Dunham and Wright reported virus-like growths from a series of 7 of 18 patients but were unable to keep the viruses alive through serial passage in animals. They could not definitely state that these viruses were related to the thrombophlebitis, although they thought the possibility must be considered.

As far as we can determine, no work has conclusively demonstrated that any form of bacteria, fungus, or virus is responsible for the inflammatory reaction in any type of venous thrombosis other than the suppurative types of thrombophlebitis. It is true that the clinical picture is often typical of an infectious process, with swelling, redness, local heat, tenderness, pain, malaise, fever, tachycardia, and increased sedimentation rate with elevation of the white cell count of the blood. Most clinicians have given large amounts of antibiotic substances in the management of thrombophlebitis solely because of this classic clinical picture.

The complications resulting from superficial venous thrombosis, however, are usually not serious; nevertheless, the constant pain from the areas of thrombosis, the long period of disability, and the cost of prolonged conservative treatment should justify a reconsideration of our present therapeutic measures for this type of venous thrombosis. Pulmonary embolism is rare when the venous thrombosis is limited to the saphenous varices or veins; nevertheless, it is possible for the thrombosis to extend proximally and enter the femoral vein at the saphenofemoral junction, at the saphenopopliteal junction, or through incompetent perforating veins. This may result in partial or complete occlusion of the deep veins of the extremity and under proper conditions may even cause pulmonary embolism.

Time does not permit a more complete review of the problem of venous thrombosis; so this discussion must be confined to the method of phlebectomy which we have employed for more than 15 years at the Cincinnati General Hospital as definitive treatment for acute thrombosis of saphenous varices and veins.

## REPORT OF A CASE

Mrs. L. D., aged 46, entered the hospital because of severe pain, tenderness, swelling, and thrombosis of large varices in the right thigh and lower leg. She had had varicose veins from the right groin to the midleg for 20 years, but these caused no serious trouble until one week prior to admission to the hospital. She first noticed a painful, firm lump on the inner aspect of the right thigh just above the knee. An elastic stocking was applied, but the inflammation soon spread upward and appeared in the varices above the elastic stocking. She had fever but no chills. She had had no previous attacks of inflammation of the peripheral veins. In spite of local treatment with heat and cold, the inflammation spread to the midportion of the thigh. The pain became severer, and she was then unable to bear weight on the right foot. There was no edema of the right foot or leg.

Physical examination showed essentially normal conditions except for the right thigh and lower leg. The right great saphenous vein was enlarged and tortuous. In the midportion of the thigh there was a firm mass about 4 cm. in diameter and 8 cm. long (Fig. 1). The skin over the mass was edematous, red, and tender. The tortuous and dilated saphenous vein distal to this point was

Fig. 1.—Local swelling due to extensive thrombosis within preexisting varices of the great saphenous vein.

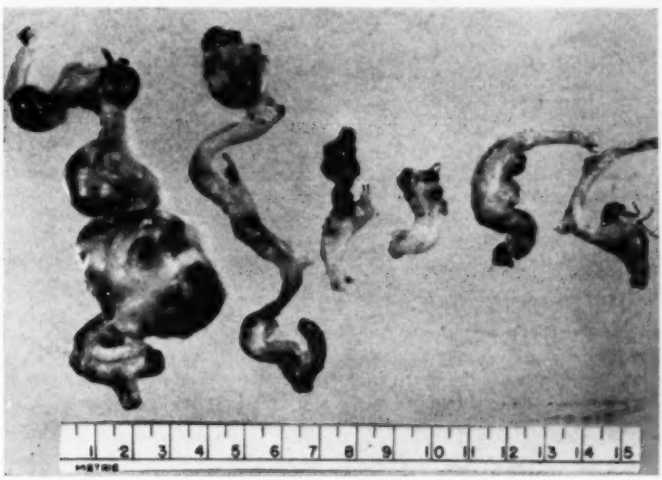


Fig. 2.—Thrombosed saphenous varices removed at operation (phlebectomy).

filled with a firm blood clot and tender to light palpation. The peripheral arterial circulation was normal.

The patient had been given 400,000 units of penicillin S-R (procaine penicillin and buffered crystalline penicillin for aqueous injection) on admission to the hospital. Anticoagulants were not given.

On the following morning the patient was operated upon. With the patient under cyclopropane-oxygen anesthesia, the saphenous and the femoral veins were exposed. The great saphenous vein was enlarged, and the valves in its upper portion were incompetent. The branches of the saphenous vein were ligated and divided, and the great saphenous vein was ligated close to the femoral vein with a transfixed suture of silk. Through multiple "buttonhole" incisions the entire saphenous vein and its enclosed blood clot were removed by sharp dissection (Fig. 2) and all tributaries or perforating veins were ligated with fine silk. The incisions were closed with interrupted sutures of silk in the skin.

Aerobic and anaerobic cultures of the excised varices and blood clots were sterile. The report of the pathologist was as follows: "The gross specimen consists of five segments of veins 3 cm. to 14 cm. long and all showing marked tortuosity and localized segmental bulbous dilatation up to 3.5 cm. in diameter. At these points of dilatation the vein walls show thinning. Microscopic examination shows, in some regions, thickening and fibrosis of the vein walls with scattered inflammatory cells in the wall of the vein. In some regions there is marked hyalin thickening of the intima and there is atrophy and fibrosis of the rest of the vein wall with a few scattered

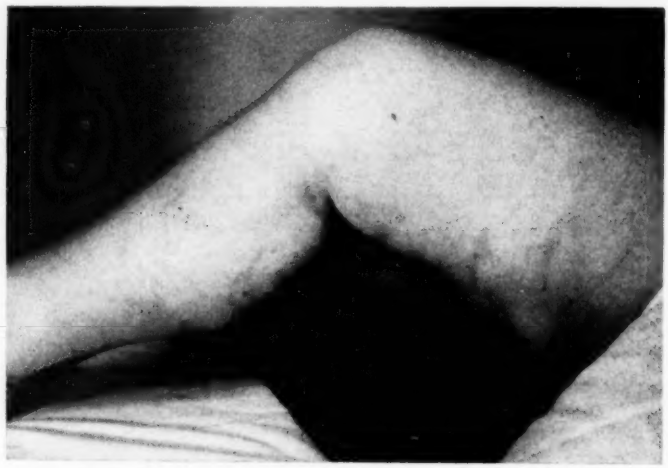

Fig. 3.—Small scars of "buttonhole" incisions faintly visible six months after operation.

inflammatory cells in the wall. Outside the adventitia there is mild fibrosis and a mild chronic inflammatory cell infiltration. In some of the veins there is seen an early organizing thrombus. Diagnosis: Acute and chronic phlebitis."

The postoperative course was uneventful. The patient was permitted to get out of bed on the day after the operation and was permitted to walk within two days after the operation. She left the hospital on the third day and suffered no further disability. The wounds all healed by primary union. Figure 3 shows the condition of the site of operation at the end of six months. The total period of disability after operation was three days. There have been no recurrences of areas of phlebitis.

## COMMENT

Our experience with this type of superficial venous thrombosis has convinced us that the process is rarely infectious in nature; so the real danger lies in the spread of the process of thrombosis to the deep veins of the affected extremity. Anticoagulants do not alter the thrombosis which has already taken place; so if they are to be effective in limiting the spread of the thrombosis they must be

continued over a period of many weeks. The expense, as well as the difficulty of keeping the coagulability of the blood at the required level, is of considerable importance to the patient.

We believe that the complete excision of the involved vein with its blood clots (phlebectomy) if performed in the early stages of the process is a simple, safe, and logical surgical procedure. If the operation is delayed until organization of the blood clots and cellular reaction about the veins becomes widespread, then the complete extirpation of the veins and the blood clots becomes much more difficult. When there is still perivenous edema, the veins can be "shelled out" with minimum effort and trauma to the surrounding tissues.

We believe that this procedure of phlebectomy should be employed more widely, for it reduces the disability to a few days, relieves the pain promptly, reduces the total cost of the illness, and eliminates the more serious complications which occasionally follow superficial venous thrombosis in the extremities.

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## DISCUSSION

DR. EUGENE A. OSIUS, Detroit: I have been extremely interested in Dr. Herrmann's presentation, as I heard his remarks on this subject some time ago, and I wish to say that I think this is an excellent addition to the treatment of acute superficial phlebitis. A similar procedure has already been done by Sherman, of San Francisco; he does not hesitate to strip a vein as well as remove the thrombosed portions of a vein if he encounters acute superficial phlebitis. Our method of handling the situation of acute superficial phlebitis of the superficial varices of the extremity has been to do an immediate ligation with thrombectomy at the site of the point of ligation if a thombus is encountered there; we consider it an emergency procedure, much like removal of an acutely inflamed appendix. A high ligation of the saphenous vein at its junction with the femoral and ligation and division of all of the branches encountered in this area are carried out with the region under local anesthesia; the extremity is supported by means of a supportive bandage, and the patient is made ambulatory immediately. Antibiotics have been used on occasion but in a rather desultory fashion. As compared with the older methods of treatment, this method has led to rapid relief in many instances, a shortening of the duration of the disease, and good subsequent results. It is true, however, that many of the varices will recur after the thrombi have been canalized and resorbed, and it is also true that in some instances considerable morbidity has been experienced because of pain in the thrombosed vessels, and hence I believe that Dr. Herrmann's addition to the treatment is a good one. He has proved it to be safe as well as efficient.

We believe that these cases present an acute emergency, and we deprecate the statement often made that emboli do not occur in cases of superficial phlebitis. We have proof and have seen cases to the contrary, and in the last case in which we found a thrombus at the saphenofemoral junction, removal of this thrombus revealed a tail on the proximal end of the thrombus approximately 1½ in. (3.8 cm.) in length. Had we had any doubt about the possibility of an embolus from acute superficial phlebitis, this case alone would have dispelled that doubt, and one case observed subsequently to reading of this paper has again verified this feeling. A soft, jelly-like thrombus was removed from the proximal opening in the saphenous vein, and by its size it left no doubt that at least ½ to ¾ in. (1.3 to 2 cm.) was protruding into the current of the common femoral vein. The patient has made an uneventful recovery.

DR. LOUIS G. HERRMANN, Cincinnati: I am very happy that Dr. Osius emphasized the importance of considering surgical venous thrombosis as an acute surgical emergency. I am sure our experience has indicated that much disability can be prevented if the thrombosed veins are removed before there has been extension of the thrombosis into the important deep veins of the extremities.

# SMALL LESIONS OF COLON

## Importance of Cooperation Between Surgeon and Roentgenologist in Diagnosis and Treatment

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ESTIMATIONS made from vital statistics of the United States [1] indicate that carcinoma of the large intestine accounted for approximately 33,000 deaths in 1948. Yet no other site of internal cancer is so amenable to modern treatment, with a low morbidity and a low mortality and an encouraging survival rate. This is especially true if the disease is recognized in the early phase. In spite of medical and lay cancer education, the average duration of symptoms is still over six months in all patients coming to surgery for carcinoma of the rectum and colon. Therefore, reiteration and discussion of features and recognized concepts which if utilized will lead to the early detection and treatment of malignant and premalignant lesions continue to be vital.

The intimate relationship of polypoid lesions to carcinoma is so well established that the early detection and removal or destruction of these neoplasms is mandatory in the prevention and early treatment of carcinoma of the rectum and colon.[2]

Polypoid lesions occur in many different specific histological forms, but adenomatous polyps constitute the great majority of those occurring in the large intestine. While the diagnosis and treatment of the rare types are important, the reference to "polypoid" lesions in this discussion will be limited to adenomatous polyps. These sessile or pedunculated glandular tumefactions are considered to be true tumors.

Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 30, 1951.

From the Departments of Surgery, St. Luke's Hospital and University of Illinois College of Medicine, and the Department of Radiology, Northwestern University Medical School.

1. United States National Office of Vital Statistics: Vital Statistics of the United States 1948: Part II. Natality and Mortality Data for the United States Tabulated by Place of Residence, Federal Security Agency, Public Health Service, 1950.

2. Swinton, N. W., and Warren, S.: Polyps of the Colon and Rectum and Their Relation to Malignancy, J. A. M. A. **113**:1927-1933 (Nov. 25) 1939. Helwig, E. B.: The Evolution of Adenomas of the Large Intestine and Their Relation to Carcinoma, Surg., Gynec. & Obst. **84**:36-50, 1947. Dukes, C.: Simple Tumors of the Large Intestine and Their Relation to Cancer, Brit. J. Surg. **13**:720-733, 1925. Bargen, J. A.; Cromar, C. D. L., and Dixon, C. F.: Early Carcinoma of the Colon: The Nature and Adequate Treatment of Carcinomas, Arch. Surg. **43**:192-208 (Aug.) 1941. Swinton, N. W.: Diagnosis and Treatment of Mucosal Polyps of the Rectum and Colon with Early Malignant Change, Am. J. Surg. **75**:369-373, 1948. Swinton, N. W.: Significance and Frequency of Benign Polyps of the Colon and Rectum, Am. Pract. **2**:603-605, 1947-1948. Helwig, E. B.: Benign Tumors of Large Intestine: Incidence and Distribution, Surg., Gynec. & Obst. **76**:419-426, 1943.

They have been amply demonstrated to be premalignant lesions, and there is sufficient evidence to state that most of them if given sufficient time will develop into carcinomas. The frequent multiplicity of these lesions tends to increase this incidence. The pathogenesis of adenomatous polypoid lesions of the rectum and colon has been extensively studied by Dukes, Bargen, Swinton, Warren, and others, and the transition from benign adenoma to carcinoma has been repeatedly demonstrated. Whether all carcinomas of the colon and rectum have their origin in polypoid lesions is somewhat questionable. Swinton, Warren, and others have demonstrated that at least 15% do, and the general opinion is that the incidence is much higher.

Fixation, firmness, induration, or ulceration of a polyp may suggest the possibility of malignant change being present, but these gross features cannot be relied upon. There is no positive method of determining the exact nature of any polypoid lesion except by adequate histological examination of the entire tumor, including its base. Malignant change may occur in any portion, regardless of form, size, location, or number. The generally accepted criterion for a conclusive diagnosis of malignancy (suggested by Swinton and Warren and used by Helwig and others) is the demonstrated presence of any two of the following histological findings: anaplasia, irregularity in the glandular architecture, and invasion. The presence of lymphatic or vascular invasion alone is usually conclusive. However, many transitional forms and hidden areas of manifest carcinoma occur which often make an exact diagnosis difficult. The occurrence of these features frequently makes it impossible to establish a positive diagnosis by frozen section. This difficulty is appreciated when one is dealing with polypoid lesions of the colon.

One of us (F. L. M.) is becoming convinced that segmental resection of the colon and its mesentery is the ideal treatment rather than polypectomy or destruction of polyps through a colotomy. Welsh[3] recently advocated this procedure and stressed the justification of the more radical operation. This attitude does not apply to most rectal polypoid lesions within reach of the proctosigmoidoscope, where repeated postoperative observation is possible.

## INCIDENCE

Statistical studies have shown that the incidence of polypoid lesions of the colon and rectum is much higher than generally suspected, variously estimated at from 7 to 17%. Carcinoma of the rectum and colon is most frequent in patients between 35 and 70 years of age, although cancer below the age of 35 years is not uncommon. This age incidence corresponds to that of polyps. The occurrence of polyps and carcinomas in the various sites corresponds very closely, i. e., 60 to 70% in the rectum and rectosigmoidal region and 30 to 40% in the colon.

## SYMPTOMS AND SIGNS

Less than half of all patients in whom polypoid lesions are found in the rectum and colon will have symptoms referable to the lesions. Not until the surface of the tumefaction is broken or ulcerated will bleeding occur, and not until multiplicity or sufficient size is attained will bowel habits be altered or obstructive symptoms produced. It is obvious that these signs and symptoms are not those produced by early

3. Welsh, C. E.: The Treatment of Polyps of the Colon, Surg., Gynec. & Obst. **93**:368-369, 1951.

lesions. Occasionally a polyp will attain great size or multiplicity without gross bleeding or obstructive symptoms. Again, in other infrequent instances, obstruction may be the first manifestation.

## DIAGNOSIS

It is quite apparent that a large, hard, lobulated, ulcerated polyp or a frank carcinoma in any form did not begin as such but had its origin in a cell or group of cells which by some little understood inherent or acquired growth defect gradually developed from microscopic to macroscopic proportions. A polypoid lesion thus produced is the earliest grossly recognizable manifestation of a cancer or a potential cancer which can be detected by modern diagnostic procedures, i. e., proctosigmoidoscopic examination of the rectum and rectosigmoidal region and roentgenologic examination of the colon. The exception to this is the infrequent carcinoma appearing to develop directly from the mucous membrane devoid of adenomatous polypoid characteristics. This rare type can be detected proctoscopically but is usually never detected in the early phase in the colon roentgenologically.

Sixty to 70% of the polypoid lesions of the rectum and colon are within reach of the 25 cm. proctosigmoidoscope, and lesions less than 5 mm. in diameter frequently can be detected. There is no substitute for this direct examination of the rectum and rectosigmoidal region. Roentgenologists make no claim of efficiency in the examination of this portion of the large intestine.

The detection of the remaining 30 to 40% of the lesions occurring in the large bowel is not so simple. It is dependent upon adequate and often upon special roentgenologic examinations. Even if a dependable test for the presence of cancer were available, the responsibility of demonstrating the location and possible multiplicity of these premalignant and malignant lesions would rest upon the results of cooperative investigation by the surgeon and the roentgenologist. In some instances several examinations may be required to detect and confirm the presence of suspected or small polyps. The incidence of malignant change in polyps removed from the colon being many times greater than in those of the rectum emphasizes the responsibility of early detection of polypoid colon lesions.

Roentgenologic examination using the ordinary heavy barium enema may suffice to demonstrate numerous lesions of the colon, but many are overlooked, especially small ones and those occurring in regions difficult to clear of overlapping or inaccessible to manipulation. The use of the air-contrast enema technique, external compression methods, and tannic acid-barium solutions for critical mucosal-pattern studies has greatly improved the accuracy of detection of small neoplasms; but unless optimum conditions are present or the lesions situated in favorable regions, many of the smaller tumefactions can be overlooked. Even with all these methods available, the surgeon at the time of operation must carefully examine the entire colon by palpation and often must investigate questionable regions by direct examination or by observation with a proctosigmoidoscope through one or more colotomies.

One of us (R. M. P.), using barium enema solutions of reduced density [4] and the high-voltage technique, is able to detect effectively small polypoid lesions of the colon. Neoplasms having a diameter of less than 1 cm. have been identified frequently.

4. Poppel, M. H., and Bercow, C.: The Use of a Modified Opaque Barium Sulfate Mixture in Roentgenography of the Colon, Am. J. Roentgenol. **51**:727-729, 1944.

We have found that this technique is a distinct addition to the detection of early malignant or premalignant lesions of the colon.

The ordinary barium enema soultions usually employed in routine colon investigation and by some roentgenologists in special examinations is so dense that the displacement of barium in the filled colon by small intraluminal lesions may not be demonstrated fluoroscopically or on films. By use of solutions of reduced density, the small differential in density resulting from displacement of the contrast medium by tiny lesions can be detected on films made with good penetration (i. e., high kilovoltage technique). In the detection of small colon lesions we are interested primarily in contrast within the bowel and not contrast between the bowel and surrounding tissues. As with any method of colon study directed at the detection of small lesions, extreme care must be taken in the preparation of the patient to produce a clean bowel which has not been irritated to the point of intolerance to examination. This preparation must be individualized. At examination the colon is filled under fluoroscopic control with dilute barium solution (approximately 4⅓ oz. [130 cc.] to the quart [0.95 liters], well suspended). Films are made of the large bowel so that all portions are free from overlap if possible, and, if necessary, using angulation and external pressure to separate the loops. Most films are made with 90 to 100 kv. and about 30 ma. When this technique is used as a special examination in search of polypoid lesions, the films are developed and examined while the patient evacuates. A postevacuation film is then made. Areas of decreased density in the colon are suspected of being lesions. Confusion may result from trapped air or gas bubbles, overlapping gas, variations in bone density, and diverticula; but retained fecal masses produce the greatest confusion.

If there are any suspected areas or if the films of the bowel are not complete and satisfactory, the bowel is again filled with dilute barium solution and films are made of the suspected areas, with or without pressure as indicated. Any pattern of decreased density within the bowel which is duplicated on two films with evacuation in between is considered to be a lesion attached to, or a part of, the bowel wall. Most pedunculated lesions which shift position appreciably have a pedicle large enough that it can be demonstrated. It is unlikely that fecal masses of similar size will be demonstrated in the same position during two examinations. The large lesions can be detected fluoroscopically.

Patients with multiple lesions provide the greatest roentgenologic problem. Even when the presence of one or several polypoid lesions has been reasonably well established by x-ray study, it is sometimes desirable to confirm these findings with another roentgen examination prior to surgery.

Previous to operation, the roentgenologist should review the films with the surgeon, indicating the location and size of demonstrated neoplasms and pointing out suspected lesions which careful study has failed to confirm. This cooperation will enable the surgeon to make additional examinations at the time of laparotomy in order that the treatment may be complete.

If an increasing number of premalignant lesions and carcinomas are to be detected, especially in the early phase of development, the scope of the indications for complete intestinal investigation must be widened. While a proctosigmoidoscopic examination is indicated at every opportunity and should be a part of every general physical examination, especially on patients beyond the age of 35, it is hardly

practical to have all of these patients subjected to complete intestinal investigation. However, x-ray examination is indicated on the slightest suspicion, and more specifically, the following situations demand a cooperative proctologic and roentgenologic examination.

1. One of the most positive indications for complete intestinal investigation is the presence of one or more of the following *unexplained* signs or symptoms: secondary anemia, persistent or intermittent change in bowel function, abdominal pain or cramps, or a palpable intra-abdominal tumor. These manifestations are not those of an early lesion. The sequence of investigation is a careful taking of the history and complete general examination followed by stool and proctosigmoidoscopic examination and, regardless of findings, a roentgenologic study of the colon. If the results are questionable, one or more reexaminations may be necessary. A brief case report serves to illustrate this situation.

Case 1.—G. D. F., a woman aged 65, entered St. Luke's Hospital in 1949, with a 12-month history of progressive weight loss, abdominal cramps, alternating diarrhea and constipation, and, more recently, intermittent mild distention and passage of blood-streaked stools. No previous gastrointestinal investigation had been done, and treatment had consisted of various bizarre diets and medication. General examination revealed evidence of malnutrition, anemia, and a palpable tumor deep in the left lower abdomen. Proctosigmoidoscopic examination demonstrated a large ulcerated papillary rectal polyp. A barium enema, fluoroscopically controlled, revealed an obstructing intraluminal mass at the junction of the descending and sigmoid colon. The rectal lesion was removed, and histological examination showed it to be a benign papillary adenomatous polyp. A large ulcerated intraluminal carcinoma of the upper sigmoid colon was widely resected. Gross and microscopic examination revealed no evidence of metastasis. Repeated proctosigmoidoscopic and roentgenologic examinations have shown no evidence of recurrence or new growths.

2. When there is a history of rectal bleeding with or without adequate demonstrable proctoscopic explanation, ideally a roentgenological examination of the colon is indicated. Bleeding is one of the earliest and most frequent signs associated with polypoid lesions and carcinoma of the rectum and colon, but bleeding from internal hemorrhoids or other anal conditions too frequently leads to the delayed detection and treatment of serious lesions which may be concurrent. The following two case reports illustrate features of this situation.

Case 2.—J. E., a woman aged 38, requested advice in 1948 concerning frequent episodes of rectal bleeding present for four months. Proctosigmoidoscopic examination revealed nothing of significance except for blood-tinged mucus coming down from higher reaches of the intestine. An air contrast barium enema x-ray study of the colon indicated a questionable small polypoid lesion in the sigmoid which was not confirmed by a second examination. Three weeks later, with use of the reduced density high-voltage technique, the presence of a small polyp in this location was demonstrated twice. An ulcerated sigmoidal polyp, 2 cm. long by 1.4 cm. in diameter with a pedicle 5 cm. long, was removed transabdominally, and microscopic examination revealed it to be a benign ulcerated adenoma. There has been no recurrence of bleeding, and repeated follow-up proctosigmoidoscopic and roentgenologic examinations have shown no evidence of recurrence or new growth.

Case 3.—N. T., a woman aged 47, entered St. Luke's Hospital in 1950, for investigation and treatment referable to episodes of rectal bleeding present for 18 months. Two hemorrhoidectomies had been performed elsewhere during this period, but bleeding had increased in frequency and severity. Findings on proctosigmoidoscopic examination were negative. Roentgenologic study of the colon revealed a polypoid lesion in the sigmoid (Fig. 1). Transabdominal removal of this ulcerated polyp, 2 cm. in diameter with a pedicle 8 cm. long, was followed by histologic examination revealing it to be a benign ulcerated adenomatous polyp.

3. When proctosigmoidoscopic examination reveals one or more polypoid lesions, with or without symptoms, a careful roentgenologic search of the colon is indicated to rule out the possible presence of other premalignant or malignant lesions at one

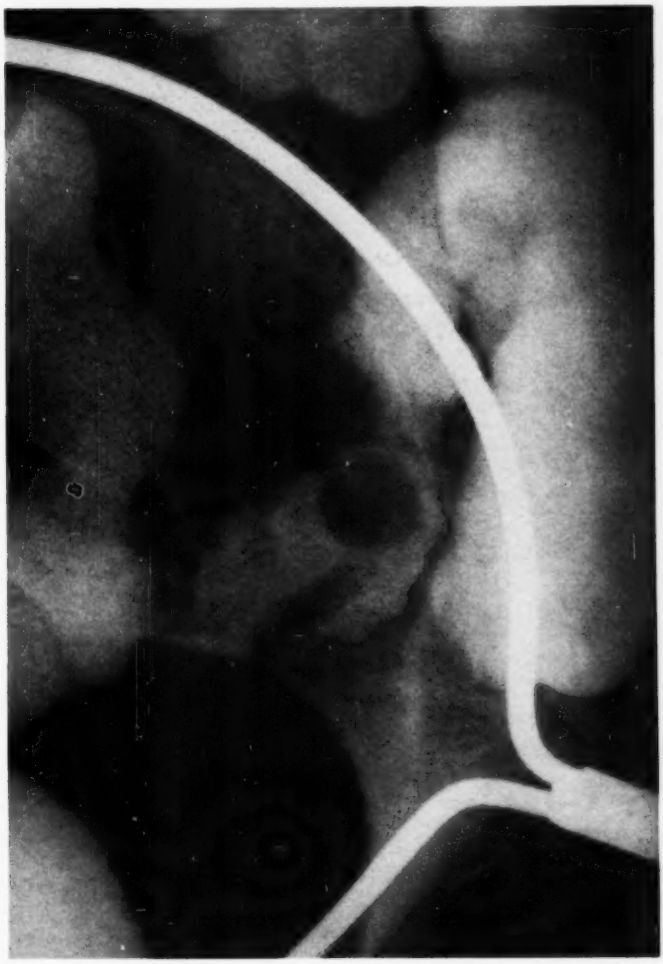

Fig. 1.—Sigmoid polyp 2 cm. in diameter with pedicle 8 cm. long, proved histologically to be benign ulcerated polyp.

or more sites. Over 40% of the polypoid lesions found will be multiple. The succeeding case report demonstrates the significance of this situation.

CASE 4.—C. S., a man aged 69, entered St. Luke's Hospital in August, 1951, with a history of intermittent loose stools of many years' duration, especially when he was under stress. Periodically during the past six months, the stools had been blood-streaked. Complete gastrointestinal investigation, four months previously, showed only a moderate degree of diverticulosis of the sigmoid colon. During the recent hospitalization, proctosigmoidoscopic examination

revealed a small sessile polyp in the rectum. Histologically the removed specimen was a benign adenoma. The result of an air contrast barium enema x-ray study of the colon was negative, but slight bleeding continued to occur periodically. One month later roentgenologic examination, using the reduced-density high-voltage technique, demonstrated two polypoid lesions in the splenic flexure of the colon (Fig. 2). This portion of the bowel was resected and contained two polyps: one, 2 cm. long by 2.5 cm. in diameter with a pedicle 1.5 cm. long, and the other, 1.5 cm. long by 1 cm. in diameter with a pedicle 2 cm. long. Both were proved to be ulcerated benign adenomas.

4. When a carcinoma of the rectum or rectosigmoid is discovered proctoscopically, the possibility of one or more concurrent malignant or premalignant neoplasms in higher reaches of the large intestine must be ruled out roentgenologically and by examination at the time of surgery if the treatment is to be complete. It is obvious that complete x-ray study of the colon is contraindicated in the presence of obstruction. Of practical value is the knowledge that in approximately 25% of

Fig. 2.—Two polypoid lesions of splenic flexure of colon, one 2.5 cm. in diameter and the other 1 cm. in diameter; both were benign ulcerated adenomatous polyps.

all resected specimens of carcinoma of the rectum and colon one or more adjacent polyps are found. This figure would be much higher if the entire extent of the large bowel were considered. In addition, approximately 5% of all carcinomas of the large intestine are multiple. As a rule, proctosigmoidoscopic examination should precede roentgenologic study of the colon, but in case a colon lesion has been demonstrated by roentgenologic examination alone the same principles apply conversely and a preoperative proctoscopy is definitely indicated. An illustrative case report follows.

Case 5.—W. B. K., a man aged 62, entered St. Luke's Hospital in February, 1950, for treatment of "polyps of the colon" which were asymptomatic. In 1939, a proctosigmoidoscopic examination done elsewhere had revealed a rectal polyp. No further investigation or treatment was carried out until 1941, when continued vague intestinal symptoms led to the roentgenologic demonstration of a large lesion of the sigmoid colon, but no proctoscopic examination was done at this time. Segmental resection of a carcinoma of the sigmoid (by another surgeon) revealed

no gross or microscopic evidence of metastasis. In January, 1950, a periodic roentgenologic follow-up examination revealed several small polypoid lesions of the cecum, one or possibly two of the transverse colon, one or more in the descending colon, and one near the anastomotic site of the previous resection (Fig. 3). Proctosigmoidoscopic examination disclosed a firm, fixed polypoid lesion, 2 by 3 by 3 cm. with an ulcerated crater at its apex, located at the site of the polyp previously found in 1939. Histological examination of removed portions proved the lesion to be an adenocarcinoma.

A combined abdominal perineal resection was performed, and five small polyps were removed from the cecum, one from the transverse colon, two from the descending colon, and one with the resected specimen just above the old anastomotic site. Inspection of the lumen of the entire large

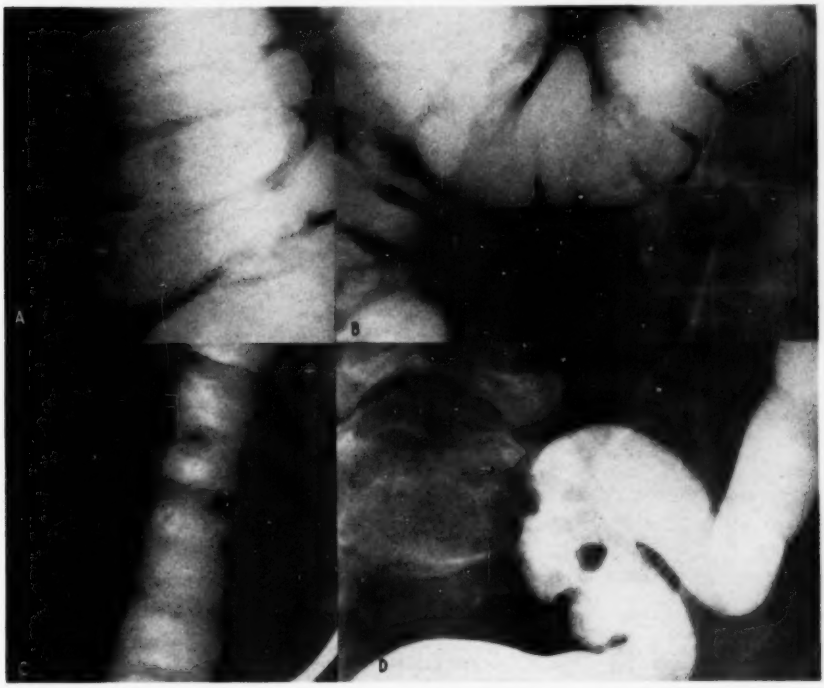


Fig. 3.—*A*, five small polyps of cecum; manifest carcinoma was present in the largest one. *B*, small polyp of transverse colon. *C*, two small polyps of descending colon. *D*, moderately large polyp near old anastomotic site in lower sigmoid colon; manifest carcinoma was present.

bowel was accomplished with a sterile proctosigmoidoscope through the various colotomies. There was no gross or microscopic evidence of metastasis, but manifest carcinoma was found in one cecal polyp and in the one near the previous anastomosis. In view of this patient's carcinogenic tendency, a total colectomy, including the rectum and anus, probably should have been done; however, frequent follow-up examinations, roentgenologically and proctosigmoidoscopically through the colotomy opening, have revealed no recurrence or new growths to date.

5. After destruction, polypectomy, or resection of one or more polyps, or surgical extirpation of a carcinoma of the rectum or colon, proctosigmoidoscopic and roentgenologic follow-up examinations must be repeated indefinitely. Recurrence is common, new growths frequently occur, and overlooked growing small lesions may

become discernible. It would appear that the inherent or acquired growth defect which produced the original neoplasm still remains. The following case report exemplifies the preceding situation.

CASE 6.—F. M. D., a woman aged 60, entered St. Luke's Hospital in September, 1950, for investigation of rectal bleeding intermittently, present for three years. In 1949 several rectal polyps were removed elsewhere, but no further investigation was done. Prior to the recent hospitalization, a proctosigmoidoscopic examination demonstrated two small sessile polyps at the site of the ones previously removed. Roentgenologic investigation disclosed a polypoid lesion in the lower descending colon (Fig. 4). The removed specimens were all proved to be ulcerated benign adenomatous polyps.

6. In the investigation of any part of the gastrointestinal tract, a proctosigmoidoscopic and roentgenologic examination of the colon is indicated because of the high

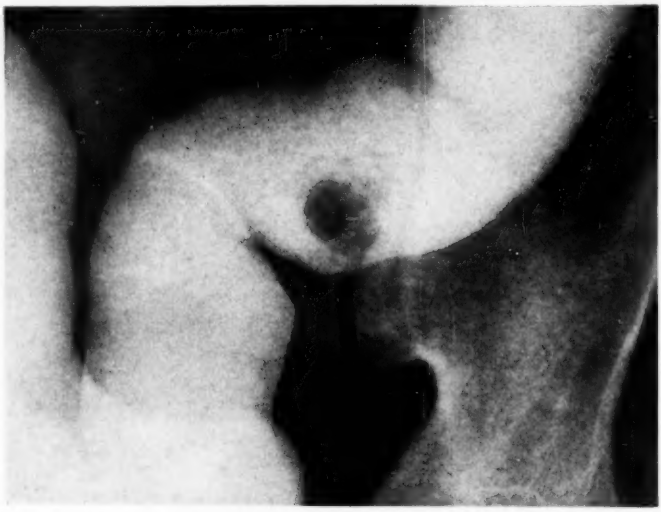

Fig. 4.—Polypoid lesion in lower descending colon. Resected specimen was ulcerated benign adenomatous polyp.

incidence of malignant and premalignant lesions of the rectum and colon and the infrequent signs and symptoms in the early phases of their development. The following case report, one of many, serves to emphasize the importance of complete investigation.

CASE 7.—W. P., a woman aged 45, entered St. Luke's Hospital in June, 1951, for investigation of a suspected peptic ulcer but with no symptoms referable to the intestinal tract. Complete gastrointestinal examination three months previously failed to reveal any abnormality. Prior to the most recent hospitalization, proctosigmoidoscopic examination showed no abnormality, examination of the upper gastrointestinal tract revealed a duodenal ulcer, and roentgenologic study of the colon demonstrated a polypoid lesion in the sigmoid. The removed polyp, 1.5 cm. long by 1.5 cm. in diameter with a pedicle 4 cm. long, histologically was a benign adenomatous lesion.

7. When familial or acquired polyposis is suspected or diagnosed by history and proctosigmoidoscopic findings, confirmation of the diagnosis and estimation of

the distribution and extent are often accurately demonstrated by special roentgenologic techniques, but these findings should be verified at the time of surgery.

8. Finally, when the rectosigmoidal region is fixed or angulated or when the sigmoid is redundant or adherent, diligent proctosigmoidoscopic and roentgenologic examinations are required to insure that questionable areas are adequately examined, especially when a lesion is suspected. In no other situation is the importance of cooperation between the surgeon and the roentgenologist so well exemplified.

## SUMMARY

The relationship of polypoid lesions to carcinoma of the large intestine has been stressed statistically, pathologically, and clinically.

Justification for widening the scope of indications for complete intestinal investigation is discussed.

Evidence is presented showing that the "reduced-density high-voltage" roentgenologic technique of examining the colon is a valuable addition to the detection of early small lesions.

Emphasis is placed on the need for cooperation between the surgeon and the roentgenologist in the early detection and treatment of lesions of the large bowel, frequently earlier than they are manifested clinically.

General as well as specific indications for proctosigmoidoscopic and roentgenologic examinations of the rectum and colon are outlined and illustrated.

## CONCLUSIONS

A thorough knowledge of carcinoma and precancerous lesions, together with complete cooperative effort by the surgeon and roentgenologist, is an absolute prerequisite in the detection and treatment of malignant and potentially malignant neoplasms of the rectum and colon in their earliest macroscopic stage of development, and often before they are manifested by clinical signs or symptoms.

122 S. Michigan Ave.

## DISCUSSION

DR. STANLEY R. MAXEINER, Minneapolis: Dr. Potter, the co-author, would like to discuss this paper.

DR. ROBERT M. POTTER, Chicago: Dr. McMillan has indicated the eight situations in which cooperative study of the colon by the surgeon and roentgenologist is necessary. Examination of the bowel above the range of the proctosigmoidoscope is the responsibility of the roentgenologist. Small polypoid lesions of the colon may be very difficult to detect, and extreme care in preparation and examination of the patient must be exercised.

Larger lesions may be easily detected by our technique provided that the bowel can be cleared from overlap. For example, this 2 cm. polyp [slide] is clearly demonstrated in the diverticulous sigmoid colon. In like manner this pedunculated 2.5 polypoid lesion in the descending colon [slide] was easily found fluoroscopically and recorded on films. We have been successful in demonstrating some very small lesions. In this 200 pound man [slide] an 8 mm. lesion of the transverse colon [slide] and a 5 mm. lesion in the descending colon have been demonstrated repeatedly. Demonstration of these two lesions in the ascending colon, 8 mm. and 10 mm. in diameter [slide], has been repeated on separate examinations. This 4 mm. lesion [slide] was demonstrated repeatedly alongside the pedunculated 11 by 7 mm. polypoid lesion. This 210 lb. (95.2 kg.) man [slide], who had two tiny lesions removed from his rectum, was found to have four tiny lesions in his sigmoid. One measures 10 by 6 mm., and two measure about 3 to 4 mm. and another about 5 mm. in diameter. We found also in careful review of the films of the two

examinations two other tiny, 4 to 5 mm., lesions in the transverse colon. These six lesions were removed by Dr. McMillan. This case illustrates well the value of careful and persistent x-ray study in cooperation between the surgeon and the roentgenologist.

DR. KENNETH C. SAWYER, Denver: I believe that papers of this type will always be timely, and I think that these were excellent papers.

However, I believe that preparation of the patient's colon before the patient is sent for barium enema studies deserves some emphasis.

In the Presbyterian Hospital in Denver our radiologists on the surgical service have adopted the following method of preparation: The patient receives 1 oz. (30 cc.) of castor oil the night before the examination, then reports without breakfast, and has a tap water enema from one to two hours before the barium study. That he have sigmoidoscopy is mandatory, but he never has it on the day of the barium enema study.

Saline purges clean the bowel, but accomplish it by drawing water into the intestine. The result is an atonic colon with a thickened, edematous wall. Under these conditions small polypoid lesions are frequently overlooked. Castor oil produces a tonic bowel with irritable but pliable walls. Many times small polypoid lesions split the head of the barium stream and in this way can be detected. The patient's breakfast should be omitted because of the gastrocolic reflex. Not infrequently the contents of the distal portion are emptied into the right side of the colon by this reflex, and careful examination is much more difficult.

If one does proctoscopy and then sends the patient for a barium enema, it is very, very difficult to outline the walls of the colon accurately.

# CARCINOMA OF RECTOSIGMOID AND UPPER PART OF RECTUM

## Recurrence Following Low Anterior Resection

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AND
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ROCHESTER, MINN.

IN RECENT years surgeons have debated the proper treatment for cancers in that part of the terminal colon variously described as "rectosigmoid," "upper rectum," or "lower sigmoid." The controversy is still unsettled. The literature is replete with reports of studies done on cadavers and on surgical patients. Much time and effort have been expended in surveying the mode of spread of these cancers. Occasionally the reader is confused because evidence developed in the attempt to prove one part of the controversy will later be used by another authority in the attempt to prove what might appear to be just the opposite. At present most surgeons have decided the question for themselves; they have continued to apply surgical procedures that they think best in their own hands and have abandoned certain other procedures which they think have not proved adequate. One wonders occasionally whether some of this reasoning is based on the fact that one operation may be easier than another, or whether it may actually have been thought by the surgeon to be a better operation although he had no factual proof at his disposal. At present sufficient exact information is needed on the effectiveness of the various operations in eradicating cancer and the permanence of the surgical results. The literature shows considerable dependence on the five-year survival rates. Some of the patients still alive at the end of five years, however, may actually be experiencing recurrence of their disease and mere existence may well be intolerable. Without detracting anything from the time-honored combined abdominoperineal operation of Miles, which we hasten to recognize as the one truly proved operation, we must admit that this operation has yielded results far short of the surgeon's expectations with regard to the cure of cancer in more than a few cases.

For more than 40 years [1] surgeons have been performing an operation which has become known as the "low anterior resection." Early attempts were followed by peritonitis in many cases, but in isolated instances results were surprisingly good. One of the modern pioneers in this field is Dixon,[1] who has been performing this operation frequently since 1930. We have followed Dixon's lead and have employed this operation; we have studied his methods closely and have appreciated his advice and encouragement.

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Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 30, 1951.

From the Division of Surgery, Mayo Clinic (Dr. Judd), and the Mayo Foundation of the University of Minnesota (Dr. Bellegie, Fellow in Surgery).

1. Dixon, C. F.: Anterior Resection for Malignant Lesions of the Upper Part of the Rectum and Lower Part of the Sigmoid, Ann. Surg. **128**:425-442 (Sept.) 1948.

Some surgeons will never use low anterior resection. Some of them consider it a poor operation because they themselves never perform it. Others state that, since recurrences are inevitable in a certain percentage of cases after combined abdominoperineal resection, there is no logical basis for ever attempting a less radical operation.

Although this reasoning is difficult to contest, there can be little doubt in the mind of the serious investigator that at some clinics the radical sacrifice of the entire terminal portion of the colon, the anus, and its sphincters is applied in too many cases. On the other hand, occasionally the wrong patients are forced through some type of sphincter-saving procedure which may result in a more or less normal mechanism of defecation, but the happiness on the part of the patient and surgeon alike is of short duration.

Because of these conditions we reviewed the literature concerning anterior resection and undertook a study of a series of our cases.

## REVIEW OF THE LITERATURE

In a large series of cases of malignant lesions of the lower part of the sigmoid and upper part of the rectum reported by Dixon,[1] the hospital mortality rate after low anterior resection was 5.9%, but in many of these cases the operations were accomplished prior to the introduction of antibiotics and all other modern adjuncts. In 270 cases with surgical treatment under more modern conditions, Dixon's hospital mortality rate was only 2.6%. The five-year survival rate in all his cases was 67.7%, and the 10-year survival rate was 49.8%. Dixon compared results of low anterior resection with results of the combined abdominoperineal procedure in a parallel series. He found that the survival rate in the cases in which the lesion was below the pelvic peritoneal fold and in which the combined abdominoperineal resection was carried out was definitely shorter than in those cases in which the lesion lay above the fold. The five-year survival rate of patients who had lesions from 10 to 14 cm. from the dentate line was only 57.9% when combined abdominoperineal resection had been used. Dixon presented an admirable description of the technique of low anterior resection.

Previously Rankin [2] had made a strong case for combined abdominoperineal resection and argued that "sentiment for the sphincter muscle is hardly a logical reason for selecting an operation. The true measure of a procedure is the longevity curve."

Cattell,[3] working at the Lahey Clinic, indicated that combined abdominoperineal resection was the only operation to be considered whenever a modified Mikulicz procedure could not be accomplished. Anterior or abdominal resection had been performed in only 5.9% of his cases. In his cases, however, the rectal stump was merely left in place without anastomosis, and thus his operation is not comparable to the resection described by Dixon. Also working at the Lahey Clinic, Colcock and Mace [4] stated their present (1951) conclusions in regard to this controversy.

2. Rankin, F. W., and Johnston, C. C.: Surgical Treatment of Cancer of the Rectum and Rectosigmoid, J. A. M. A. **136**:371-375 (Feb. 7) 1948.

3. Cattell, R. B.: Carcinoma of the Colon and Rectum: A Report of 503 Patients Treated at the Lahey Clinic 1938-1941, Inclusive, Surgery **14**:378-386 (Sept.) 1943.

4. Colcock, B. P., and Mace, A. J.: Choice of Operative Procedure in Treatment of Carcinoma of the Rectum, Lahey Clin. Bull. **7**:139-144 (July) 1951.

They conceded that "anterior resection has a place in the treatment of cancer of the rectosigmoid or that segment of the pelvic colon which lies above the anterior reflexion of the peritoneum." In 1949, however, at that clinic, only eight patients with lesions of the rectosigmoid had undergone anterior resection with anastomosis; in seven of these, the resection was listed as palliative.

Waugh and Kirklin [5] stressed the importance of the lateral spread of the lesion and pointed out that even after combined abdominoperineal resection, if that spread was beyond the reach of the surgeon, poor results would be predictable. It was evident to them that when the growth is far enough away from the dentate line that an adequate length of normal bowel may be resected below the lowermost limits of the growth anterior resection is just as radical as combined abdominoperineal resection, since the amount of tissue lateral to the bowel and that included in the mesenteric segment removed is just as great as in the combined abdominoperineal resection. This point seemed to them to be overlooked by the outspoken critics of anterior resection. Waugh and Kirklin, like others, based their conclusions on survival rates, and information concerning presence or absence of recurrent malignant disease is not available in their series of cases.

Garlock and Ginzburg [6] presented a critical survey of their experience with anterior resection. They found a local recurrence rate of 35.7% and a pelvic recurrence rate of 7.1% in cases in which lesions were low in the rectum. In cases in which lesions were higher or in the rectosigmoid, the local recurrence rate was only 3.3% and the pelvic recurrence rate was 1.6%. Their series was a relatively small one, and they urged others to survey similar series in order to obtain a guide for future decisions. They concluded that the exact location of the tumor is the most important criterion and initiated their study on that basis. They pointed out that neither Dukes's classification nor Broders' grading scale could be used as a final criterion during the operation, since considerable time is needed to classify the condition. From their small series they decided that low anterior resection was rarely justified for cancers of the rectum which were less than 5 in. (12.7 cm.) from the anus. The impelling reason for this decision was inability to resect enough normal bowel below the tumor for proper cancer surgery. They stressed, however, that they were well pleased with anterior resection for cancers lying in the rectosigmoid, and they were convinced that abdominoperineal resection is not necessary for every cancer in that area. They have abandoned low anterior resection except for the higher-lying lesions.

Dunning, Jones, and Hazard [7] analyzed 102 cases in which combined abdominoperineal resection was employed. In addition to the survival rates, they had definite information in regard to the recurrence of the carcinoma. At operation they found perineural extension of carcinoma in 10 cases. Eight of the patients were dead of recurrent cancer within four years after operation. In an additional 22 cases, the patients had died of recurrent malignant lesions before two years had elapsed, a

5. Waugh, J. M., and Kirklin, J. W.: The Importance of the Level of the Lesion in the Prognosis and Treatment of Carcinoma of the Rectum and Low Sigmoid Colon, Ann. Surg. **129**:22-33 (Jan.) 1949.

6. Garlock, J. H., and Ginzburg, L.: An Appraisal of the Operation of Anterior Resection for Carcinoma of Rectum and Rectosigmoid, Surg., Gynec. & Obst. **90**:525-534 (May) 1950.

7. Dunning, E. J.; Jones, T. E., and Hazard, J. B.: Cancer of the Rectum: A Study of Factors Influencing Survival Following Combined Abdominoperineal Resection of the Rectum, Ann. Surg. **133**:166-173 (Feb.) 1951.

gross recurrence rate of 22.5%. In these 22 cases, 11 of the tumors were 5 cm. or less from the anus; 4 were from 6 to 12 cm.; and 7 from 13 to 22 cm. from the anus. It appears from their study that in most of these recurrent cancers the tumors were definitely of type C (Dukes's classification) and of higher grades on Broders' scale.

Dunphy and Broderick [8] presented one of the most telling arguments against anterior resection by tabulating the local recurrence rates of a group of other authorities. They cited Gilchrist and David,[9] who had reported that a 20% incidence of local recurrence following abdominoperineal resection was a rather standard rate. Dunphy and Broderick were particularly distressed at the high rate of local recurrence reported by various surgeons following anterior resection for very low-lying lesions. They concluded that anterior resection should be employed only

(1) to extend the scope of resection for lesions of the lower sigmoid colon; (2) to avoid colostomy in the presence of distant metastasis provided that the local disease can be completely extirpated, and (3) to restore continuity of the bowel in carefully-selected cases of cancer of the upper rectum and lower pelvic colon in which the pelvic fascia is not invaded, there are no obvious lymph node metastases and there is a minimal operative margin of 10 cm. below the tumor.

## TERMS USED

All surgeons must admit that "rectosigmoid" is a poor term. The anatomists will present arguments which may prove various details, but, surgically speaking, some surgeons think of the rectosigmoid as the last 2 in. (5 cm.) of the sigmoid and the first 2 in. of the rectum. This may be as workable as any definition. Other surgeons consider the rectosigmoid as the point where the taeniae disappear and there is no free mesentery as such but the bowel is closely applied to the sacrum. The pelvic peritoneal fold also comes in for a great deal of comment. The location of this structure is so variable that it is difficult to use it as a landmark. All are familiar with the widspread discussion concerning it in regard to the nature of the metastatic spread, and some go further in the attempt to use this peritoneal fold and its relation to the location of the carcinoma as an index for prognosis. In our experience, the most practical point to be stressed about this is that in cancers lying in this area complete and proper mobilization of the entire rectum will remove all of the peritoneum, so that the lower segment of the bowel does not possess a serosa for the application of any type of anastomotic suture.

Following the logical approach of Dixon and realizing the shortcomings and debatable points, we have selected the proctoscopic measurement as our arbitrary criterion of the site of the lesion. This is as standard, convenient, and consistent as any; it is simple and quick; it eliminates the variations in location of the pelvic peritoneal fold, the technical changes produced in the level by proper surgical mobilization, and the inevitable shortening of the bowel immediately on division. With these thoughts in mind then, in our study, as in Dixon's, we arbitrarily described the site of the lesion as the distance in centimeters of the lowermost extremity of the carcinoma from the dentate line of the anus, as measured by the proctoscopist. Our study will confine itself to tumors 20 cm. or less from the

8. Dunphy, J. E., and Broderick, E. G.: A Critique of Anterior Resection in the Treatment of Cancer of the Rectum and Pelvic Colon, Surgery **30**:106-115 (July) 1951.

9. Gilchrist, R. K., and David, V. C.: Prognosis in Carcinoma of the Bowel, Surg., Gynec. & Obst. **86**:359-371 (March) 1948.

dentate margin. Although many surgeons today still insist on radical extirpation of the anus and its sphincters, even in cases of carcinoma of the sigmoid colon the preponderance of thought appears to favor anastomosis in such cases; therefore, we have arbitrarily eliminated all of the higher lesions from our review.

## MATERIAL FOR STUDY

The records of the Mayo Clinic from 1936 through 1945 (10 years) were surveyed for cases in which low anterior resection was performed for malignant lesions 20 cm. or less from the dentate margin. The period chosen afforded a significant number of cases and also allowed a follow-up study of at least five years in every case. The operations were performed by a group of seven surgeons. "Pull-through" operations were not included.

During this period 308 patients had survived low anterior resection for carcinoma of the upper part of the rectum and rectosigmoid and had been dismissed to their homes. Twenty-six of the operations were listed as palliative resections, and they will be considered separately. Thus, 282 patients had at least some possibility of control of their disease at the time of dismissal. The follow-up study was largely a matter of repeated examination at the clinic. By far the most important part of the examination was proctoscopic observation. This was carried out as part of every examination. In addition, the majority of the patients had undergone roentgeno-

TABLE 1.—*Per Cent Recurrence Within Five Years**

| Years After Operation | Location of Lesion Above Dentate Line | | |
|---|---|---|---|
| | 10 Cm. or Less, % of 60 Cases | 11 to 15 Cm., % of 159 Cases | 16 to 20 Cm., % of 61 Cases |
| 1 | 18.3 | 10.7 | 1.6 |
| 2 | 33.3 | 22.0 | 6.6 |
| 3 | 38.3 | 25.8 | 13.1 |
| 4 | 40.0 | 28.3 | 16.4 |
| 5 | 41.7 | 30.2 | 16.4 |

* All cases in which recurrences or distant metastasis developed are included.

logic examination of the colon from time to time, and the usual complete physical and laboratory examinations were recorded. Most of the patients were observed repeatedly during the intervening years.

## RECURRENCES

*Recurrence Rates.*—The recurrence rates are best expressed in tabular form (Table 1). The high recurrence rate for the low-lying lesions may be noted. One might argue that approximately a third of the patients with recurrences had recurrence throughout the pelvis and hence that perhaps radical sacrifice of the entire lower segment of the bowel might not have yielded any better results. The inescapable fact remains, however, that more than 25% of the patients had recurrence within the bowel only. As might be expected, the farther the lesion lay from the dentate line, the less likelihood of recurrence; in fact, lesions which lay well up within the rectosigmoid region showed a surprisingly low incidence of local recurrence. This has been the most gratifying portion of the study.

It must be stressed that Table 1 presents all types of recurrences and includes as recurrences distant metastatic lesions. We do not have such complete information in cases in which combined abdominoperineal resection was performed at the Mayo Clinic, nor is it available in the literature. It is apparent that the customarily quoted recurrence rates of 20 to 22.5% after that operation do not include all recurrences. Therefore, with the exception of the group in which the lesion lay

10 cm. or less from the anus, the results of the operation known as low anterior resection compare favorably with those of combined abdominoperineal resection.

*Survival Rate.*—Table 2 merely gives conventional listing of the five-year survival rates. It corroborates information previously available and parallels the findings reported by Dixon [1] in a similar series. We were struck by the relatively high five-year survival rate in those cases in which low-lying lesions were present and in which we found such a high recurrence rate. This merely underscores the dictum (which should become much more widespread than it is) that the five-year survival rate does not give a complete appraisal of a cancer operation. It is possible that many of the patients who are alive at the end of five years, especially those who had colonic cancers, may be living in utter misery. More than 70% of the patients who had high-lying lesions were living five years after operation, but we must remember that a small percentage of these patients also had recurrences.

*Relationship to Pathologic Aspects of the Primary Lesions.*—We had expected that the more rapidly growing type of tumor which had already gone beyond the confines of the bowel would be the one most likely to recur. We attempted to correlate our impressions by employing the modified Dukes classification of extent

TABLE 2.—*Five-Year Survival Rates According to Location of Lesion*

| Location of Lesion Above Dentate Line, Cm. | Patients | | Lived 5 or More Years After Operation | |
|---|---|---|---|---|
| | Total | Traced | Number | Per Cent * |
| 10 cm. or less | 60 | 59 | 34 | 57.6 |
| 11 to 15 | 159 | 159 | 102 | 64.2 |
| 16 to 20 | 63 | 61 | 45 | 73.8 |
| Total | 282 | 279 | 181 | 64.9 |

* Per cent of traced patients (inquiry as of Jan. 1, 1951).

of spread. There is some correlation between extent of spread and recurrence, since those patients who had no recurrence at all appeared to be predominantly drawn from that group of patients who had little spread beyond the confines of the bowel. It was at once apparent that no local recurrence followed a type A lesion. Attempting further to correlate recurrence with the grade of malignancy with the aid of the Broders grading scale, we found that the situation was too complicated for complete breakdown into small categories. Taken with the Dukes classification, grading gave very consistent results in that those patients with no recurrence at all had lesions of low grade. Recurrences tended to appear in cases in which the malignancy was of higher grades.

*Time of Onset.*—For the group of our patients operated on in 1940 or earlier 41% were living and well with no sign of recurrence more than 10 years after the resection. Those who exhibited recurrence at all did so largely long before the first five years had elapsed. These findings correspond well with Dixon's [1] findings, although his charts show survival rates only. As has been reported by others, we found that many of our patients were completely free of demonstrable malignant change (by proctoscopic examination) for at least 18 months after anterior resection. The significant change appeared to fall in the interval between 18 and 24 months after operation. It is difficult to set an actual date of onset of recurrence, as many symptoms may exist in persons who are entirely well and some months

may elapse before others will report to their physicians; however, in going over the records, we were impressed that approximately 22 months following resection seems to be an average period for the appearance of recurrent malignant lesions. In a separate study, done along parallel lines and reported previously with Long and others,[10] we found that the interval between anterior resection and reoperation in cases of recurrence averaged 33 months; however, this was a small series and enough of these patients had undergone some other type of treatment prior to the reoperation to account for this discrepancy in time of onset as just stated and of operation. A most significant fact brought out by Long, however, is that in the case of the entirely new (or independent) carcinoma, having no relation to the original growth, the interval between low anterior resection and the second operation averaged 49 months.

*Pertinent Observations.*—We found that, in general, the grade of the lesion and the Dukes type of the lesion remained the same when recurrence was demonstrated, but this did not always hold true. When significant differences in the grades were found, the possibility of an entirely new growth seemed likely. In a lesion of Dukes's type C and of the higher grades of the Broders scale, the nature of recurrence was almost predictable.

In our five-year survival group, we found that a small percentage of patients were living in a moderate degree of comfort, in spite of a low-grade locally limited recurrent lesion, the treatment of which will be discussed later.

Examination of the inguinal nodes did not appear to yield significant information in follow-up studies, probably because the lesions originated at a level considerably higher than lesions which affect inguinal nodes. We found, too, that we had relied heavily on the proctologist for objective evidence of recurrence at follow-up examinations. When recurrence was observed within the bowel, his notation concerning fixation, angulation, and obstruction often formed the basis for the surgeon's decision. Apparently in some cases the condition was considered hopeless, and perhaps rightly so, but it has struck us that the key to the problem of recurrent growth is a second operation for more and more of these patients in spite of what may appear to be discouraging proctoscopic findings.

*Further Surgical Intervention.*—We were disappointed to find from this study that so few of the patients with recurrence had undergone further surgical treatment. In the light of present policy, we expected many more to be operated on. At present, the means of preparing the intestinal tract for safe operation is so effective that surgeons have become bolder. Our hope, as just indicated, is that more and more of these patients will be extended the benefits of further surgical intervention. In the previous study, reported with Long and others,[10] we found that only 10% of the patients with recurrent lesions underwent subsequent operation, and it was disappointing to note that the mean survival time of patients with recurrences who were operated on was only 1.5 years and that only one patient was living five years after the second operation. Among patients who had new carcinomas (definitely not recurrent lesions) the average survival time was 5.4 years after a second resection.

10. Long, J. W.; Mayo, C. W.; Dockerty, M. B., and Judd, E. S., Jr.: Recurrent Versus New and Independent Carcinomas of the Colon and Rectum, Proc. Staff Meet., Mayo Clin. **25**:169-178 (April) 1950.

In the present series, five patients were alive five years after the second resection. Colostomy only was performed on five other patients, with recurrent lesions at the clinic. Out of all the patients who had recurrent lesions, only one was treated by means of abdominoperineal resection of the Miles type. This was the greatest surprise of our entire study. We know that in more recent years our tendency has been to undertake that procedure more frequently for recurrent lesions, in spite of the fact that extreme technical difficulties predominate. Radical pelvic exenteration may offer some hope.

*Nonsurgical Treatment.*—Analysis of our series from this standpoint revealed that 19 patients were sent home immediately after reexamination disclosed the recurrence. In most of these cases, of course, lesions were of type C (Dukes) and of high grade (Broders) at the time of resection. It was somewhat distressing to read the surgeon's notes expressing frustration at the time of reexamination. The surgeon may have found some small comfort in the fact that the demonstrable rectal recurrence was only a part of the general recurrence.

In regard to the use of radium, we found a limited sphere of usefulness; in fact, in five cases of recurrence, radium alone yielded surprisingly good prolonged control. One patient was in excellent health 10 years after the radium treatment; however, in 20 other cases no benefit was demonstrable after application of radium. In three isolated instances, complete control of the local recurrence by radium was demonstrated on repeated biopsy specimens removed through the proctoscope, but in each of these cases death occurred some months later from metastatic carcinoma. Radium treatment was combined with roentgen therapy in three cases and results indicate that some degree of control was achieved. In six other cases roentgen therapy alone was employed and the results are extremely questionable. In this regard, the radium therapist now seems much more prone to use vigorously complete therapy if the recurrence is not lying too close to the bladder and if a colostomy is present, which will obviate the colonic obstruction resulting frequently from such vigorous treatment. It may be that the more modern methods will extend the survival rates considerably.

## PALLIATIVE RESECTION

In addition to the 282 patients dismissed to their homes with some hope of prolonged survival, 26 underwent what was listed as a palliative anterior resection during the same period. We found that the reasons for the palliative operations were involvement of the liver in nine cases, massive involvement of lymph nodes and veins in nine and distant malignant implants in eight. Strangely, the primary growth was less than 10 cm. from the anus in only two of these cases. We surmised that the surgeon had reasoned that for growths in the higher level palliative resection could be carried out more readily and with considerably less risk, and for that reason many more of the patients who had palliative operations had high-lying lesions than low-lying ones. The surgeons were much less likely to undertake the operation for pure palliation when the growth was at a very low level.

The treatment of the recurrent neoplasm in these cases in which a palliative procedure had been done was about what we had expected—namely, radium in five, colostomy in two, and symptomatic treatment in the others.

Among patients with known recurrence, the interval between resection and onset of recurrence was appreciably shorter in the group with palliative operations than

in the larger series. This may mean that in the palliative operations the surgeon deliberately divided the bowel closer to the lower margin of the growth than he would ever do in the other group.

A follow-up of the 26 patients whose resections were considered palliative disclosed that all had died. Only one patient lived five years after resection, and he died during the sixth year; he was known to have a recurrence. Nine of these patients had local recurrences prior to death; 7 others died from metastatic carcinoma, and we have no definite information as to recurrence or cause of death of the remaining 10.

## COMMENT

That the abdominal part of the Miles operation does not differ in any way from that of the anterior resection has not been stressed enough. We are convinced too that certain of the extremely malignant growths will exhibit recurrent tendencies later, in spite of the Miles operation.

All surgeons interested in this problem have seen occasional patients returning for observation after Miles's operations who complained of pain in the lumbar and sacral region or pain in the perineum, even extending down one or both legs. There may be vague abdominal discomfort also. Repeated examination will reveal no malignant lesion. The critics of the anterior resection then must remember that after the Miles operation there may well be just as much recurrence as after anterior resection, but it simply cannot be demonstrated. The patient with the anterior resection will have the same symptoms but perhaps, added to these, may have those of a rectal recurrence.

A fact which we believe worthy of considerable emphasis, too, is that more than 70% of the cancers of the entire colon and rectum are within that area of bowel visible to the proctologist.[11] Should not the surgeon be more aware of that basic fact and prepare his patient for the future by eliminating not only the present cancer but the possibility of a new growth in the "fertile field" below the anastomosis? We have the feeling that the first operation should be considered the one golden opportunity and that we should strive to reduce the possibility of being forced ever to consider further resection. The great propensity to save the normal defecation mechanism, though hailed with great enthusiasm by the patient in his early months of postoperative life, may actually prove to be the greatest disfavor that could have been performed for him in the first place.

## SUMMARY AND CONCLUSIONS

Combined abdominoperineal resection, then, still remains the operation of choice in the majority of cases of carcinoma of the rectum.

The recurrence rates in 282 cases following anterior resection were studied; included as recurrences were all forms of recurrences and metastatic lesions in these cases. The usual rates given in the literature for combined abdominoperineal resection are not as inclusive. From this study the following observations were made.

1. For lesions situated from 16 to 20 cm. from the dentate line of the anus, anterior resection can be accomplished at low risk with an excellent five-year survival rate and a recurrence rate of only 16.4%.

11. Jackman, R. J., and Mayo, C. W.: The Adenoma-Carcinoma Sequence in Cancer of the Colon, Surg., Gynec. & Obst. **93**:327-330 (Sept.) 1951.

2. For lesions situated 11 to 15 cm. from the dentate line, anterior resection is followed by a five-year recurrence rate of 30.2%.

3. For lesions 10 cm. or less from the dentate line, the five-year gross recurrence rate in this series is 41.7%. This had led us to restrict sharply our use of the operation when lesions were in this situation.

4. Recurrence of the carcinoma within the bowel was found to be about twice as frequent as that in the pelvis.

Properly performed, low anterior resection controls the upward and the lateral zones of spread in exactly the same fashion as does combined abdominoperineal resection. Adequate removal of bowel below the carcinoma rests directly with the surgeon.

The first operation is the "golden moment." Treatment for recurrent rectal carcinoma can rarely be as aggressive as the surgeon would desire.

## DISCUSSION

DR. R. RUSSELL BEST, Omaha: I have been very much interested in Dr. Judd's paper, and I certainly subscribe to the very important remarks which he has made. I refer particularly to what may be done for the patient with a recurrence.

Dr. Judd stated that usually we are not able to locate recurrent cancer until it has become inoperable. This is certainly true after an abdominal perineal resection. However, with a person who has had an anterior or posterior resection with anastomosis, I believe time will support the remark that frequently we will be able to attempt a removal of the recurrence at a later date; one, two, three, four, or even five years later. As long as three years after surgery we have reoperated upon a patient and have been successful in removing the recurrent tumor by abdominal perineal resection in three cases. Of course, we must expect high percentage of secondary recurrence in such cases, but it does give one an opportunity for another resection with possible success or at least another lease on life.

I have one more remark about these recurrences. If one does a proctoscopic examination on these patients with anterior or posterior resections with anastomosis, one can usually see the irregular line of the anastomosis, and early in this group of patients I always suspected a recurrence in this area. However, as one becomes more familiar with the irregular appearance of the anastomotic site, one is better able to distinguish variations which might be cancer and might not be cancer. Of course, when a suspicious irregularity of the anastomosis is noted, the patient should be urged to come for observation frequently.

I believe that many of us have been guilty of trying to remove too many lesions too low. Now I have placed the level for anterior resections at about 10 cm. and believe that when we have a lesion lower than 10 cm. we should resort to anterior dissection and then turn the patient over for a posterior resection and anastomosis.

May I have the slide please?

[Slide] What I am interested in here is the lymphatic spread at the level of the levator ani muscle. I believe our failure in the past has been in not going widely enough in removing the levator ani fascia and muscle. In our anatomical studies, which extended over a period of several years, we have felt that we have added nothing in the way of anatomical knowledge, but we do feel that we have emphasized, to ourselves at least, that a lesion less than 10 cm. from the anorectal opening should be removed by anterior dissection to eradicate the zone of upward spread, and then the levator ani muscle and fascia should be removed as far as possible by posterior resection and anastomosis.

# CARCINOMA OF THE COLON

## A Study of End-Results of Surgical Treatment

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COLLER and Vaughan,[1] in 1945, discussed certain aspects of the treatment of carcinoma of the colon observed in this clinic during the preceding five-year period. They considered in detail a series of 173 consecutive cases of colonic carcinoma, exclusive of lesions of the rectum, treated by all forms of surgical procedure other than abdominoperineal resection. The following conclusions were drawn: 1. At the time of operation 16.2% of the patients presented lesions too far advanced for any type of resection, and for these patients only palliative decompression or short circuiting procedures could be carried out. 2. Resection was feasible in 83.8% of the cases; of the patients for whom resection was performed 19% had gross metastases in the liver or peritoneum, and hence these resection operations were palliative in nature. 3. In 112 cases, or 64.7%, there was no gross evidence of carcinomatous spread beyond the regional lymph nodes; in this group permanent arrest of the disease appeared to be a possibility. 4. There was only one operative death in the group of cases in which there was a chance for cure; operative deaths otherwise occurred in advanced cases following heroic attempts to remove widespread disease. 5. The resection mortality was 4.1% and the over-all mortality 7.5%.

The present report is concerned with the late results of definitive surgical treatment and includes those patients with carcinoma of the colon who were successfully treated by extirpation of the lesion and discharged from the hospital alive during the years 1934-1949 inclusive. This period of time, longer than that in the Coller and Vaughan study, was adopted in order to provide larger groups of cases for assessment, thus reducing the likelihood of statistical error, and also in order to observe the course of the treated disease over relatively long periods of time, e. g., 5 to 15 years following treatment. While surgical mortality is constantly being reduced by improvements in and standardization of techniques and by such adjuncts as new antibiotics, blood banks, etc., and while technical methods may vary from time to time, nevertheless the fundamental principles of resection for cancer, i. e., a radical excision of the tumor-containing segment of bowel along with a generous removal of adjacent lymph-node-bearing tissues, remain essentially unchanged or at least sufficiently so as to make permissible the inclusion of the group of earlier

From the Department of Surgery, University of Michigan.

Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 30, 1951.

1. Coller, F. A., and Vaughan, H. H.: Treatment of Carcinoma of the Colon, Ann. Surg. **121**:395-411, 1945.

cases. The study was undertaken to determine, if possible, the following points: (1) the value of palliative resections of the colon in the presence of hepatic metastases or irremovable local extensions of disease; (2) the over-all survival rate for the entire group of patients who had operation for cure, regardless of the stage of the disease and irrespective of the several variables which may influence prognosis; (3) the influence on survival rate of the anatomical position of the lesion, i. e., in the right, mid, or left colon; (4) the influence on survival rate of microscopically verified metastases in regional lymph nodes; (5) the influence on survival rate of penetration of the neoplasm through the bowel wall with extension into the

TABLE 1.—*Classification by Sex and Age*

| | |
|---|---|
| Resections 1934-1949 inclusive | 448 |
| Males | 237 |
| Females | 211 |
| Average age of all patients | 57.1 yr. |
| Average age of males | 55.2 yr. |
| Average age of females | 59.2 yr. |
| Oldest male | 80 yr. |
| Youngest male | 18 yr. |
| Oldest female | 79 yr. |
| Youngest female | 23 yr. |

TABLE 2.—*Anatomic Position and Surgical Procedures*

| Anatomic Classification | | Surgical Procedures | |
|---|---|---|---|
| Segment | Number of Cases | Operation | Number of Cases |
| Right colon | 146 (32.6%) | One-stage resection | 30 |
| | | Two-stage resection | 113 |
| | | Obstructive resection | 3 |
| Midcolon | 74 (16.5%) | Obstructive resection | 21 |
| | | Resection-anastomosis | 48 |
| | | Two-stage resection | 5 |
| Left colon | 228 (50.9%) | Obstructive resection | 45 |
| | | Resection-anastomosis | 173 |
| | | Two-stage resection | 3 |
| | | Hartmann procedure | 7 |

adjacent adipose or connective tissue, e. g., mesentery or omentum; (6) the influence of the histological pattern of the tumor on survival rate; (7) an evaluation of the worth of reresection for local recurrence; (8) a separate consideration of cases of multiple simultaneous and multiple nonsimultaneous primary malignant neoplasms of the colon.

## CLINICAL MATERIAL AND METHOD OF STUDY

During the period under consideration, 1934-1949, in 448 cases, excluding operative deaths, treatment was carried out by definitive surgical procedures. Pertinent data regarding these 448 patients are given in Table 1. At the time of the original operation in each case a solitary malignant neoplasm of the colon was resected. Cases of multiple simultaneous primary carcinoma are considered in a later section. For convenience the colon has been arbitrarily divided into three

main anatomic segments or zones, i. e., the right colon, including the cecum, ascending colon, and hepatic flexure; the midcolon, comprising the transverse colon and splenic flexure; and the left colon, made up of the descending colon, the sigmoid, and the rectosigmoid junction. The group of cancers at the rectosigmoid level treated by anterior resection is exceedingly small, since in this clinic the Miles abdominoperineal resection is usually employed for such low-lying lesions. Any patients treated primarily by the Miles operation, even though the lesion was in the distal sigmoid, are excluded from this study. However, among those cases in which a secondary resection was required for local recurrence or for a new primary tumor patients treated by the Miles procedure have been included. Table 2 shows the distribution of the lesions according to anatomic position and also the surgical procedures which were employed. Nearly all the neoplasms in the right colon were dealt with by right hemicolectomy performed in either one or two stages, the two-stage procedure having been elected oftener than the one completed at a single session. Intestinal continuity was reestablished usually by an end-to-side ileotransverse colostomy. For lesions distal to the hepatic flexure the obstructive type of resection was extensively used in the earlier part of the series, whereas in 1940 this

TABLE 3.—*Indications for Palliative Operations (96 Cases)*

| Indications | Number of Cases |
|---|---|
| Hepatic metastases | 40 |
| Local extension | 41 |
| Liver and local extension | 6 |
| Distant lymph nodes | 4 |
| Second primary carcinoma (pancreas, ovary, breast) | 3 |
| Hepatic and pulmonary metastases | 2 |

technique was largely abandoned in favor of resection with primary suture anastomosis. The Hartmann procedure was used in a small number of low sigmoidal lesions. It consists of a segmental resection and the establishment of an end-colostomy as in the Miles operation but is completed by closure of the rectal stump, which is allowed to remain in situ.

## PALLIATIVE RESECTIONS

Ninety-six cases, or 21.4%, of the 448 must be considered separately since at the time of celiotomy the findings indicated a hopeless prognosis. Complete eradication of the disease was impossible because of the presence of hepatic metastases, involvement of inaccessible lymph nodes, neoplastic infiltrations into the abdominal or pelvic walls, or scattered peritoneal implantation metastases. A few patients exhibited roentgen evidence of early pulmonary metastases, and in three cases the presence of a second primary malignant neoplasm outside the gastrointestinal tract affected adversely an otherwise good prognosis. Hepatic metastases served as the deterrent to a curative procedure in half the cases in this incurable group (Table 3). Table 4 includes additional data concerning this special group of patients. Follow-up data during the last follow-up year (1950) revealed that 87 (90.6%) of the 96 patients had died. The postoperative duration of life of the 87 patients now dead is shown in Table 5, while similar data for the subgroup of 43 patients with hepatic

metastases are given in Table 6. It will be noted that the percentages for the several periods of postoperative survival are nearly identical, although the group with hepatic involvement did less well than the group as a whole. Although these figures

TABLE 4.—*Hepatic Metastases (43 Patients)*

| Lymph Node Involvement | Cases | |
|---|---|---|
| | Number | Per Cent |
| Positive | 23 | 53.4 |
| Negative | 10 | 23.3 |
| Status indeterminate | 10 | 23.3 |
| Extension through wall into adjacent adipose tissue | 24 | 55.8 |
| Involvement of adjacent adipose tissue and positive lymph nodes | 9 | 20.9 |

TABLE 5.—*Duration of Life After Palliative Resection*

| Lived | Deaths per Period | Cumulative Number | Per Cent Dead |
|---|---|---|---|
| 6 mo. or less | 33 | 33 | 37.9 |
| 1 yr. or less | 20 | 53 | 60.9 |
| 2 yr. or less | 27 | 80 | 92.1 |
| 3 yr. or less | 1 | 81 | 93.1 |
| 4 yr. or less | 4 | 85 | 97.8 |
| 5 yr. or less | 1 | 86 | 98.8 |
| 6 yr. or less | 0 | 86 | 98.8 |
| 7 yr. or less | 1 | 87 | 100.0 |

TABLE 6.—*Postoperative Duration of Life for Patients with Hepatic Metastases*

| Lived | Deaths per Period | Cumulative Number | Per Cent Dead |
|---|---|---|---|
| 6 mo. or less | 20 | 20 | 46.5 |
| 1 yr. or less | 8 | 28 | 65.1 |
| 2 yr. or less | 13 | 41 | 95.3 |
| 3 yr. or less | 1 | 42 | 97.7 |
| 4 yr. or less | 1 | 43 | 100.0 |

TABLE 7.—*Comparative Data Regarding 352 Cases of Curative Operations*

| Segment of Colon | No. of Cases | No. of Males | No. of Females | Average Age (Years) | Lymph Nodes | | Pericolic Fat | | Nodes and Fat Positive | Preoperative Surgical Decompression | Average Length of Surgical Specimen |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Positive | Negative | Positive | Negative | | | |
| Right | 125 | 63 50.4% | 62 49.6% | 57.8 | 36.3% | 63.7% | 25.6% | 74.4% | 11.2% | 4 3.2% | 31.4 cm. |
| Mid | 55 | 31 56.2% | 24 43.8% | 58.2 | 34.1% | 65.9% | 32.7% | 67.3% | 10.9% | 11 20% | 18.4 cm. |
| Left | 172 | 89 51.7% | 83 48.3% | 57.4 | 28.3% | 71.7% | 29.7% | 70.3% | 9.3% | 52 30.2% | 15.6 cm. |

are not especially impressive, it is my opinion that palliative resections are worth while in cases of this type, since nearly 10% of the group lived as long as two years. Moreover, the small number of patients who were enabled to survive from three to seven years would indicate that such therapeutic efforts are worth while. It is generally agreed that there is no zone in the gastrointestinal tract where

palliative extirpation of neoplasms affords more relief from distressing symptoms or a greater degree of physical improvement, even though it be but temporary, than in the colon and rectum.

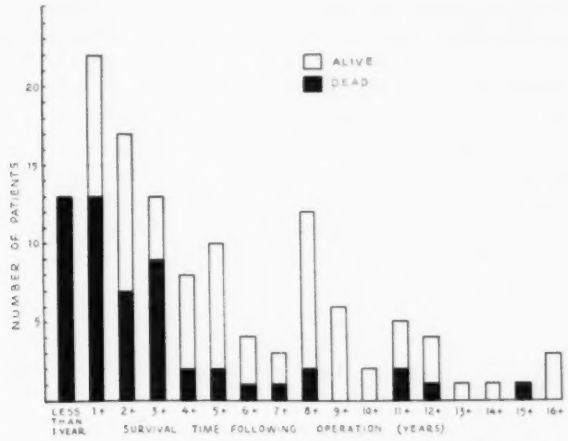


Chart 1.—Years of survival following resection of lesions of right colon (125 patients).

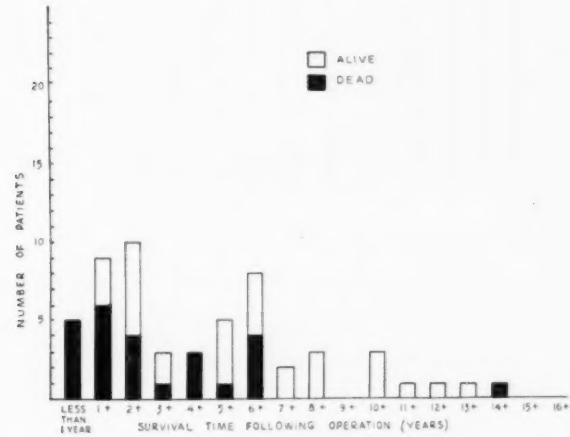


Chart 2.—Years of survival following resection of lesions of midcolon (55 patients).

## OPERATIONS FOR CURE

Three hundred fifty-two patients (78.6%) were believed to have the possibility of a cure. Table 7 presents certain miscellaneous data concerning this group of patients to which reference will be made later. Follow-up data have been obtained in all cases, and every patient has been traced from the date of discharge from the hospital to the time of his death, or, if living, to the anniversary date in 1950 of his operation.

The length of survival of patients now dead ranged from 1 month to over 16 years. At the time of the last follow-up note (1950) 153 patients had died and 199 were living. Charts 1, 2, and 3 summarize these data diagrammatically, according to the anatomical location of the tumor. The figures are not cumulative. Thirty-three patients of the 153 now dead died during the first year. Of these, 13 were among the 125 with lesions of the right colon (10.4%); 5 were in the group of 55 with lesions in the midcolon (9.1%), and 15 in the 172 with lesions of the left colon (8.7%). In each of these three charts, the heights of the black columns indicating patients now dead drop abruptly until the third year is reached, whereupon they begin to level off and become more or less stabilized at the fifth or sixth year. In these diagrams and those which follow, deaths from all causes have been impartially recorded. It is impossible to obtain data sufficiently accurate for distinction to be made between clinical cures and survivals. In the first few postoperative years many of the deaths were very clearly due to recurrent disease, a few were due to

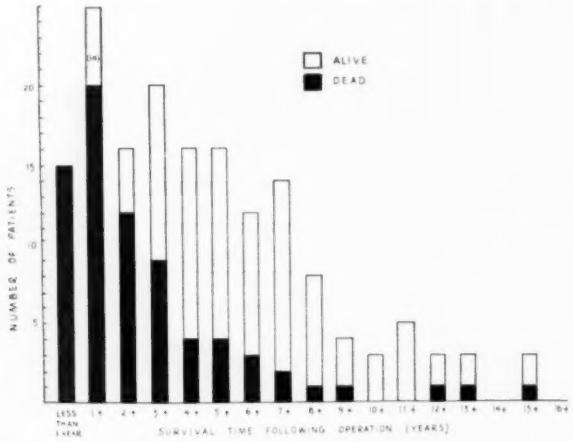


Chart 3.—Years of survival following resection of lesions of left colon (172 patients).

intercurrent disease, and a large group of cases remains in which the information obtainable is too incomplete to permit accurate evaluation. One gains the impression from a perusal of the case records that well over 80% of the deaths occurring during the first five years were due to recurrent disease, while less than 20% of those which occurred after the fifth year were due to recurrence. Hence survival rates only are used as the basis for comparison in each of the discussions to follow. Chart 4 combines in a comprehensive manner the data presented in Charts 1, 2, and 3. Here the results expressed yearly in per cent are calculated independently for each year. The percentage of survivals for a particular year is derived by dividing the number of patients alive during that unit of time by the number of patients operated upon at a time sufficiently early theoretically to have allowed their survival for the requisite number of years. The figures are cumulative and hence survivors at 12 years are also recorded at the 10-, the 7-, the 5-, and the 3-year level. The data in this chart are of interest and are most gratifying, since, according to this method of calculation and with reference to the total number of 352 patients, 72% were alive at the end of three years and 63% at the end of five years. In the group of

patients who are now living and have survived for five years or more none are known to have clinical evidence of recurrence. However, even though repeated examinations are made by the surgeon by whom the operation was performed, a conclusive diagnosis of recurrent disease is often difficult. Nevertheless, it would appear that survival for five years is of considerable importance in estimates of the ultimate prognosis and that if a patient survives for five years the chance of recurrence in the future is remote.

Because of these observations, in the charts which follow calculations are made and conclusions based on five-year survival only. This technique seems justifiable, since otherwise in the special subgroups the number of patients becomes so small at the 10- and 15-year levels that the results lose much of their significance. Moreover, considering the average age of the patients at the time of operation (57 years), it is evident that if assessments are made 10 or more years later, when deaths from intercurrent diseases, especially from those of the cardiovascular-renal system, are

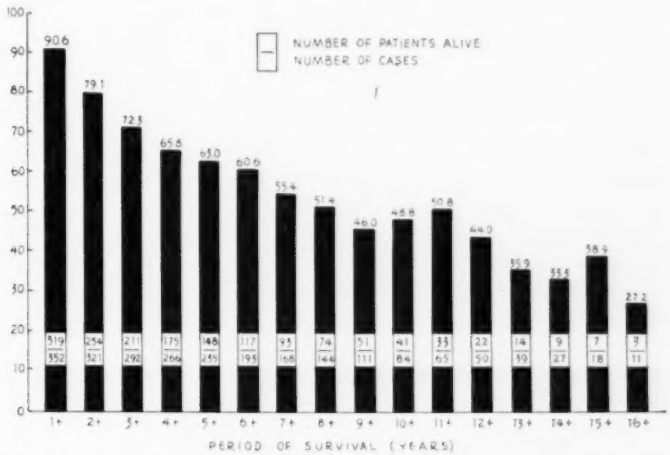


Chart 4.—Survival time for entire group of 352 patients with carcinoma of colon (living and dead). Results are expressed in per cent, and separate calculations are made for each year.

so common, the results are apt to confuse rather than clarify the picture. Therefore, in these tabulations only those patients (235) operated upon in 1945 or in the years preceding were studied, and thus even the most recent cases have been followed for a minimum of five years. The percentages recorded at one, two, three, four, and five years are derived by dividing the number of patients alive during that particular unit of time by the total number of patients who were available for the study of the particular variable under investigation and who were operated upon in 1945 or earlier.

## INFLUENCE OF ANATOMICAL LOCATION OF LESION UPON FIVE-YEAR SURVIVAL RATES

In discussions concerning the prognosis in carcinoma of the colon following resection, the statement has frequently been made that the prospects for long survival in cancers of the right colon and of the cecum in particular are better than for

lesions situated more distally. Allen and Welch [2] (1939) stated that, considering all patients lost to follow-up as dead, 71% of the patients who survived a radical resection of the right colon for carcinoma were alive five years after operation, 40% of those with lesions of the transverse colon, and 37% of those with a cancer of the left colon. When operative deaths were included, curability percentages became 47%, 28%, and 25%, respectively. Rankin and Graham [3] reported five-year cures in 57.6% of 187 cases of carcinoma of the right colon and 47.7% among 266 cases of left-colon cancer. Garlock and Klein [4] (1949) concluded that the largest number of survivals proportionately is to be found in cases of carcinoma of the right side of the colon and of the rectum in that order. They believed the prognosis for lesions of the right colon to be superior because of the greater facility of more radical resection, accompanied as it is by the excision of larger areas of lymph-node-bearing tissue. An older view expressed by Hayes [5] was that cancers of the cecum tend to metastasize to regional lymph nodes more slowly than do lesions at other levels in the large bowel. Using the routine method of microscopic study of surgical specimens, he found that nodal involvement was most common in the sigmoid flexure and that the frequency of involvement of the remaining segments of the colon was in the following order: descending colon, transverse colon, hepatic flexure, splenic flexure, and ascending colon. Rankin found nodes involved in 34% of 187 cases of carcinoma of the right colon, whereas in 31% of 266 cases of cancer of the left colon he found lymph-node metastases. The routine study of the specimens in the present series revealed the incidence of lymph-node involvement to be as follows: right colon, 36.3%; midcolon, 34.1%, and left colon, 28.3%. Studies in our laboratory (Coller, Kay, and McIntyre),[6] using the modified Spalteholtz technique as described by Gilchrist and David,[7] failed to confirm some of the earlier observations. Our studies revealed the incidence of nodal involvement to be almost exactly the same for the right and the left half of the colon (62.5% and 60.0%, respectively). However, in 1947, using this same technique, Gilchrist and David [8] in a study of 200 cases of cancer of the colon and rectum operated upon more than five years previously and a microscopic examination of a total of over 10,000 nodes, found metastases in 86.6% of their cases of carcinoma of the right colon. In contrast to this, lymph-node metastases were found in 44.4% of the cancers of the transverse colon, splenic flexure, and descending colon (left colon), and in 63.3% of the lesions of the sigmoid and intraperitoneal portions of the rectum.

2. Allen, A. W., and Welch, C. E.: Malignant Disease of Colon: Factors Influencing Operability, Morbidity and Mortality, Am. J. Surg. **46**:171-180, 1939.

3. Rankin, F. W., and Graham, A. S.: Cancer of the Colon and Rectum: Its Diagnosis and Treatment, Ed. 2, Springfield, Ill., Charles C Thomas, Publisher, 1950.

4. Garlock, J. H., and Klein, S. H.: Carcinoma of the Colon and Rectum: A 10 Year Study, Arch. Surg. **59**:1289-1303, 1949.

5. Hayes, J. M.: The Involvement of the Lymph Glands in Carcinoma of the Large Intestine, Minnesota Med. **4**:653-663, 1921.

6. Coller, F. A.; Kay, E. B., and MacIntyre, R. S.: Regional Lymphatic Metastases of Carcinoma of the Colon, Ann. Surg. **114**:56-57, 1941.

7. Gilchrist, R. K., and David, V. C.: Lymphatic Spread of Carcinoma of the Rectum, Ann. Surg. **108**:621-642, 1938.

8. Gilchrist, R. K., and David, V. C.: A Consideration of Pathological Factors Influencing 5 Year Survival in Radical Resection of the Large Bowel and Rectum for Carcinoma, Ann. Surg. **126**:421-438, 1947.

Applying the method for computing five-year survivals outlined above, a comparative evaluation of the factor of anatomic location was made. The total number of cases available for this analysis was 235, distributed as follows: right colon, 82; midcolon, 39; and left colon, 114. The results are given in Chart 5. From these data it is evident that there was no important difference in the survival rates of the three groups. Moreover, the percentages of three- and five-year survivals are again approximately 74 and 63%, respectively, essentially the same values originally obtained when the entire group was considered. With reference to Table 7, it will be noted that the lengths of the excised segments of bowel were as follows: right colon, 31.4 cm.; midcolon, 18.4 cm.; and left colon, 15.6 cm. These measurements are of relative value only, since they were not made until the specimens reached the Pathology Laboratory after they had been fixed in formalin, with the inevitable

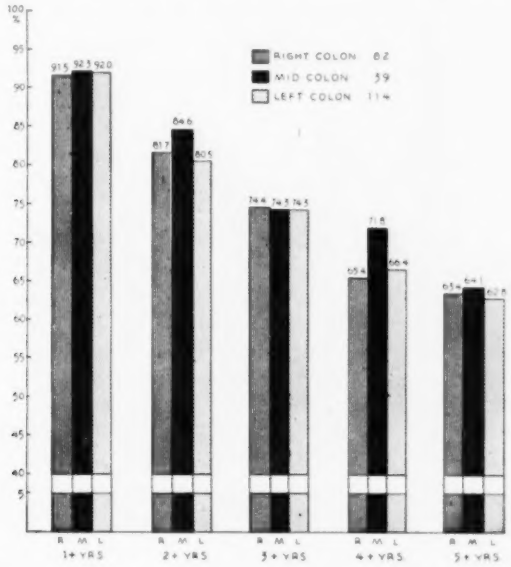


Chart 5.—Five-year survival in carcinoma of colon according to anatomic location of tumor (235 patients).

shrinkage. The greater length of bowel removed for right-sided lesions is explained in part by the intentional inclusion of a long segment of distal ileum (15 to 25 cm.) in order to expedite the removal of as many nodes as possible at the dangerous ileocecal angle. Since the current evidence indicates that nodal involvement in the right colon occurs as often as or possibly more frequently than in the left colon, and in view of the treacherous involvement of nodes at the ileocecal angle, a more radical operation would seem to be necessary for the right than for the left colon.

## INFLUENCE OF INVOLVEMENT OF REGIONAL LYMPH NODES ON FIVE-YEAR SURVIVAL RATES

In cancer of the colon, as in cancer elsewhere in the digestive tract, lymphogenous metastases with involvement of the regional lymph nodes may mean nonresectability if far advanced, or incurability if extensive. Minimal involvement of

neighboring nodes does not preclude a chance for cure provided wide excision is performed. Since size and consistency of nodes as noted at operation are not reliable indexes of metastatic involvement, a type of resection based on anatomic principles should be performed in order to permit the most thorough excision possible of nodes which may be involved. For 199 patients of the total of 235 operated upon more than five years previously, suitable data concerning the status of the regional lymph nodes were available for comparative study. Using the routine methods of examination, 62 (31.1%) of the cases exhibited involvement of nodes while in the remaining 137 (68.9%) the nodes were uninvolved. In Chart 6 are presented the survival rates for five years listing (*a*) cases with lymph-node involvement; (*b*) those without lymph-node involvement; and (*c*) the entire group for comparison. As would be anticipated, involvement of nodes by neoplasm exerted a definite and

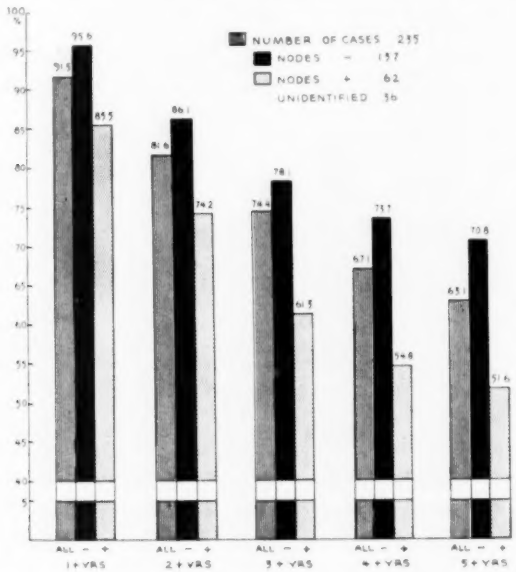


Chart 6.—Five-year survival in patients with and without regional lymph-node involvement compared with group as a whole.

deleterious effect upon five-year curability. This was quite evident by the end of the first year, and the evil effect increased gradually each year until the conclusion of the survey at the end of the fifth year. While lymphogenous extension is only one of the several modes of spread of the disease and only one of the variables which may govern the prognosis, its occurrence is readily identifiable and, regardless of other factors, is helpful in estimating the outlook for the future in any given case.

### INFLUENCE OF PENETRATION OF NEOPLASM THROUGH COLONIC WALL AND EXTENSION INTO PERICOLIC FAT ON SURVIVAL RATE

Detailed microscopic study of surgical specimens of carcinoma of the colon in our laboratory has revealed extension of the neoplasm through all coats of the intestinal wall in 93.1%. Following penetration of the bowel wall, further spread

by direct extension into the pericolic adipose or connective tissue (mesentery and omentum) may take place. This is a factor of major importance, since at some unpredictable time thereafter neoplastic invasion of blood vessels will occur with the dissemination of emboli of tumor cells to the liver by way of the portal vein. Histopathological studies of the specimens in the 235 cases under discussion revealed neoplastic extension into the pericolic fat or connective tissue in 74 (31.5%), whereas invasion had not occurred in the remaining 161 cases.

Chart 7 depicts the postoperative course of these two groups of patients during the first five years. The survival rates of the combined groups are shown for comparison. The noxious effect of invasion of the pericolic fat is clearly demonstrated. Although its unfavorable influence on survival is not quite so marked as in the case of lymph-node involvement during the first four years, the two factors become nearly equivalent (50%) at the end of the fifth year. In Chart 8 are shown the courses of two antithetical groups of cases. In one there was microscopic evidence of involvement of regional lymph nodes as well as invasion of the pericolic fat, and in the other neither of these tissues was involved. It will be noted that when both lymph nodes and fat are involved, the five-year survival rate falls to 46%, whereas in the early or more favorable cases with neither form of extension of the disease, the five-year survivals rise from the average level of 63% to over 75%.

### INFLUENCE OF HISTOPATHOLOGICAL TYPE OF NEOPLASM ON SURVIVAL RATE

There is now quite universal agreement that the biological activity or intrinsic malignancy of a given neoplasm is one of the most potent single factors affecting the prognosis. It is common experience that many of the undifferentiated or highly anaplastic carcinomas recur promptly and relentlessly in spite of early and drastic treatment, whereas certain of the well-differentiated tumors are cured clinically even after they have attained great size and have partially destroyed contiguous structures by contact involvement. Broders [9] has devised a method of expressing quantitatively these phases of malignancy, using as the criterion the degrees of cellular differentiation. His method has been employed extensively, and many authors believe that the classification of a tumor according to this grading of its degree of malignancy affords a reliable means of estimating the outlook in a given case, especially if taken in conjunction with all other available data. While agreeing fully with the fundamental principles of this method, members of the staff of the Department of Pathology of our hospital have been reluctant to grade tumors in a routine fashion. They believe that frequently too great emphasis is placed on this single factor by clinicians and that a real danger exists that treatment may be compromised or altered on the basis of such biopsic reports. This is particularly true in some of the lower grades of malignancy when because of failure to employ sufficiently radical measures a patient may be denied his best chance for cure. Accordingly, in the group of cases under discussion insufficient data on the basis of any system of grading are available for analysis or comparative study. Nevertheless, an attempt has been made to compare the results of treatment in the three most commonly observed types of carcinoma as noted on microscopic examination. With the excep-

9. Broders, A. C.: The Grading of Carcinoma, Minnesota Med. **8**:726-730, 1925.

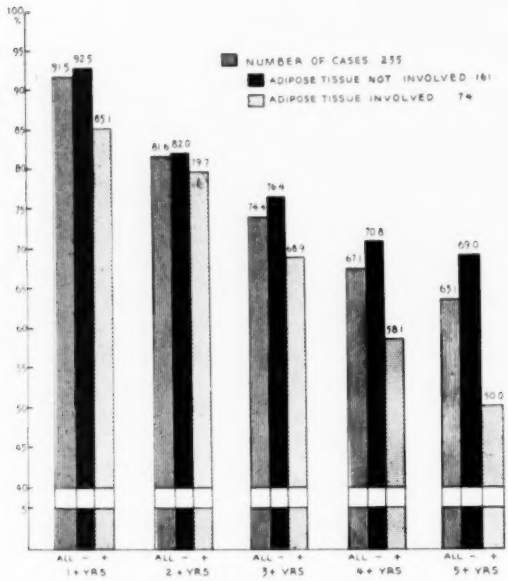


Chart 7.—Five-year survival in patients with and without neoplastic invasion of pericolic adipose tissue compared with group as whole.

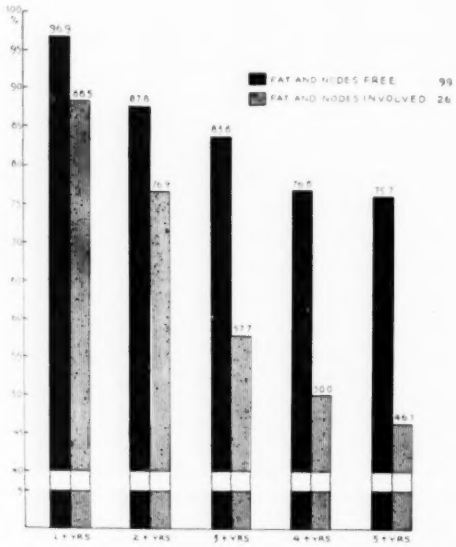


Chart 8.—Five-year survival according to involvement of both lymph nodes and pericolic fat (125 patients).

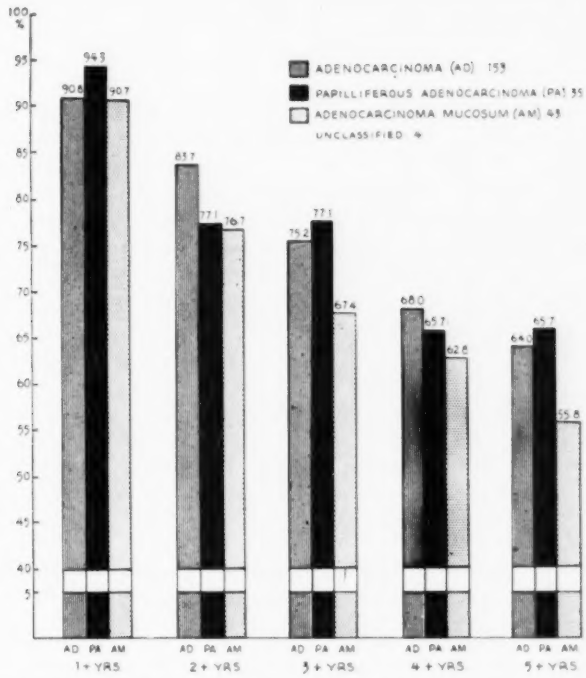


Chart 9.—Five-year survival according to histologic pattern of neoplasm—adenocarcinoma, papilliferous adenocarcinoma, or adenocarcinoma mucosum (235 patients).

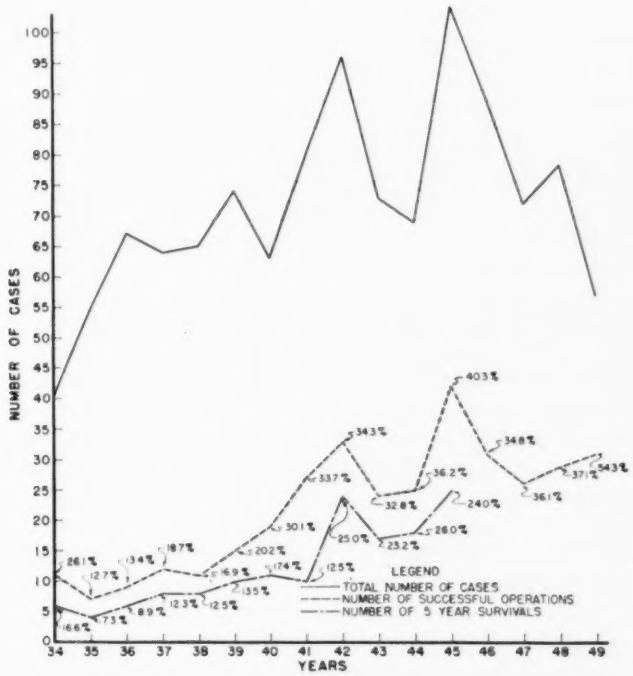


Chart 10.—Graph showing number of five-year survival by year compared with number of successful operations for cure and with total number of patients with carcinoma of the colon that were seen in the hospital.

tion of a small group of four cases which remains unclassified, since each was an unusual or unique form of tumor, the remaining 231 cases fall readily into three main categories: (1) adenocarcinoma; (2) papilliferous adenocarcinoma; (3) adenocarcinoma mucosum (mucin-forming adenocarcinoma). The survival rates for these three forms of cancer have been plotted for the five-year period in a comparative manner in Chart 9. No essential differences can be discovered in the three types of lesions, especially at the end of the first and second years. By the end of the third, fourth, and fifth years, the adenocarcinoma mucosum appears to be characterized by a slightly lower survival rate.

### RESULTS OF TREATMENT BY YEAR

In Chart 10 are shown the number of five-year survivals by year compared with the number of successful operations for cure and also with the total number of cases of carcinoma of the colon seen in the hospital. The gradual rise in the percentage of successful operations and of five-year survivals in the over-all picture is impressive.

### CASES OF MULTIPLE NONSIMULTANEOUS PRIMARY CARCINOMA OF THE COLON

Of the 352 aforementioned patients who were operated upon for carcinoma of the colon and who survived the original surgical procedure, 7 patients subsequently developed one or more additional malignant neoplasms in other portions of the large bowel. The records of these patients have been carefully scrutinized and the evidence is thoroughly convincing that the more recent tumors were new primary tumors and not recurrences of the original neoplasm. In Table 8 are given epitomes of these clinical records. Case 1 is of particular interest in that four years prior to the right colectomy for carcinoma of the cecum a total hysterectomy had been performed for endometrial carcinoma. The patient is now living and well and free from recurrence 21 years after her original surgical treatment of visceral cancer. She has had three major primary carcinomas removed surgically, two of which were independent primary neoplasms of the colon. Case 3 is phenomenal in that the patient has had four radical surgical procedures for the extirpation of five primary cancers of the colon. Presumably this is an atypical form of multiple polyposis in which a few scattered polypi not detected originally by roentgen examination later underwent malignant degeneration with the evocation of clinical symptoms. Cases 4 and 7 are quite similar in that both patients originally had resection of the sigmoid for carcinoma in that loop, and subsequently in each a new primary neoplasm developed nearby. In each case at the time of the second laparotomy the original anastomosis was easily identified and found to be free of recurrent disease. Although all these patients were operated upon originally over five years previously, only two had died. The first was an elderly man of 75 who succumbed in the hospital to a cardiovascular accident following his second resection 17 months after an initial resection of the sigmoid. The other was a man of 65 who died of cause unknown two and one-half years after combined abdominoperineal resection of the rectum. This Miles operation was performed two years after an original successful resection of the transverse colon. It seems obvious that the development of a second or third cancer

TABLE 8.—*Cases of Multiple Nonsimultaneous Carcinoma of Colon*

| Case | Sex | Age | Lesion 1 | Operation 1 | Lesion 2 | Operation 2 | Lesion 3 | Operation 3 | Lesion 4 | Operation 4 | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F | 57 | Cecum | 1-stage right colectomy 1/20/34 | Sigmoid | Resection-anastomosis 7/25/42 | ..... | ..... | ..... | ..... | Living 8/1/50 |
| 2 | F | 41 | Ascending colon | 2-stage right colectomy 8/23/37 9/15/37 | Rectum | Combined 6/30/49 | ..... | ..... | ..... | ..... | Living 10/5/50 |
| 3 | F | 61 | Sigmoid | Obstructive resection 10/4/37 | Rectum | Combined 1/23/39 | Splenic flexure | Resection and end colostomy 9/9/46 | Cecum, Ascending colon } 2 | Right colectomy and ileostomy 4/30/47 | Living 10/4/50 |
| 4 | M | 41 | Sigmoid | Resection-anastomosis 8/12/44 | Descending colon | Combined 10/12/45 | ..... | ..... | ..... | ..... | Living 12/31/50 |
| 5 | M | 73 | Sigmoid | Resection-anastomosis 10/16/44 | Rectum | Combined 3/15/46 | ..... | ..... | ..... | ..... | Died 3/26/46 (cardiovascular accident) |
| 6 | M | 65 | Transverse colon | Resection-anastomosis 2/14/45 | Rectum | Combined 5/10/47 | ..... | ..... | ..... | ..... | Died 11/7/49 |
| 7 | M | 68 | Sigmoid | Resection-anastomosis 8/21/45 | Rectum | Combined 3/25/49 | ..... | ..... | ..... | ..... | Living 12/21/50 |

TABLE 9.—*Cases of Multiple Simultaneous Carcinoma of Colon*

| Case | Sex | Age | Lesion(s) 1 | Operation 1 | Lesion 2 | Operation 2 | Lesion 3 | Operation 3 | Total Number of Cancers | Result |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M | 13 | (*a*) Transverse colon-2<br>(*b*) Sigmoid-1<br>Multiple polyposis | Obstructive resection of left colon<br>2/24/36 | Hepatic flexure | Ileosigmoidostomy<br>3/28/40<br>Right colectomy<br>4/15/40 | .....<br>..... | .....<br>..... | 4 large; multiple small | Died<br>11/11/41 |
| 2 | F | 16 | (*a*) Descending colon-2<br>(*b*) Sigmoid-1<br>Multiple polyposis | Obstructive resection of left colon<br>1/18/39 | ..... | ..... | ..... | ..... | 3 large; multiple small | Died<br>9/27/39 |
| 3 | M | 43 | Rectum<br>Multiple polyposis | Combined<br>11/27/39 | Upper sigmoid | Ileostomy<br>5/3/40<br>Colectomy<br>11/4/40 | .....<br>..... | .....<br>..... | 2 | Living<br>10/19/50 |
| 4 | F | 68 | Rectum<br>Multiple polyposis | Combined and ileostomy<br>4/16/41 | Hepatic flexure | Colectomy<br>5/13/41 | ..... | ..... | 2 | Died<br>2/9/47 |
| 5 | M | 66 | Descending colon | Resection-anastomosis<br>8/23/44 | Rectum | Perineal excision<br>11/21/44 | Recurrence (rectum) | Combined<br>1/15/45 | 2 | Died<br>5/8/45 |
| 6 | M | 59 | 2 { Ascending colon<br>Cecum | 2-stage right colectomy<br>9/6/46<br>9/17/46 | ..... | ..... | ..... | ..... | 2 | Living<br>11/8/50 |

in a patient who has attained a clinical cure following the removal of an original tumor does not denote a hopeless or necessarily a bad prognosis. It is imperative, therefore, that patients be carefully followed postoperatively and that recurrent symptoms be thoroughly investigated. Too often a diagnosis of recurrence with grave prognosis is made while a new neoplasm with a chance for cure is overlooked. It is a matter of interest that in five of these seven cases the rectum was the site of the second carcinoma regardless of the site of the initial lesion.

### CASES OF MULTIPLE SIMULTANEOUS PRIMARY CARCINOMA OF THE COLON

Table 9 presents selected data from the case records of a small group of six patients (not included in the above group of 352 with discrete carcinomas of the colon) in which multiple primary tumors were present when treatment was first undertaken. In four cases there was unmistakable evidence of multiple polyposis. In Cases 1 and 2, those of a brother and sister, there was a remarkable family history of this disease. The malignant changes in polypi were numerous and extensive, and treatment was of no avail. In Cases 3 and 4, while multiple polypi were present, carcinoma was demonstrated in only two areas each, and all four of these resections were regarded as operations capable of cure. In contrast to the group of patients with multiple nonsimultaneous cancers the results of treatment in this group were poor. Only two patients were living, and in each of these the second lesion was a relatively small ancillary tumor located near the first and one which could not have importantly influenced the prognosis. It would seem, therefore, that in patients who present at the time of the original treatment two or more advanced independent cancers, particularly when separated by some distance, the prognosis is grave.

### RERESECTION FOR LOCAL RECURRENCE

In a certain number of cases reexploration was performed when there was evidence that recurrence had taken place and particularly when the symptoms of obstruction or bleeding were present. In many of these cases an entirely hopeless situation was encountered, whereas in others a short-circuiting procedure could be performed or an external vent provided. In 12 of these cases in which reexploration was done, reresection was found to be feasible (Table 10). In Case 8 a second reresection was performed three months later, and this in turn was followed by a combined abdominoperineal resection in six months, at which time a segmental resection of a very mobile hepatic flexure was also necessitated because of contact involvement. The results in this group of cases are disappointing. With one exception all the patients had died, death having taken place within a few months following secondary resection. The one successful case was that of a man living and apparently free of recurrence nearly three years after the reresection. The predominance of cancers of the sigmoid in which recurrences amenable to secondary resection developed is worthy of note and raises two unanswerable questions: (*a*) whether a more radical excision originally might have prevented this disaster, and (*b*) whether recurrences in this area are more amenable to secondary removal than

are recurrences elsewhere, since here the Miles operation can be resorted to when necessary. One must conclude that while reresection for local recurrence may be worth while, it is almost inevitably only a palliative procedure.

## SUMMARY AND CONCLUSIONS

A group of 448 cases of carcinoma of the colon successfully treated by definitive operation (resection) during the period 1934-1949 has been reviewed with particular reference to end-results.

TABLE 10.—*Reresection for Local Recurrence*

| Case | Sex | Age | Site of Lesion | Operation 1 | Operation 2 | Operation 3 | Operation 4 | Result |
|---|---|---|---|---|---|---|---|---|
| 1 | F | 65 | Hepatic flexure | 2-stage right colectomy 8/11/41 8/25/41 | Reresection and ileosigmoidostomy 4/14/43 | ..... | ..... | Died 7/2/43 |
| 2 | M | 37 | Sigmoid | Resection-anastomosis 6/24/42 | Combined 6/17/47 | ..... | ..... | Died 10/25/48 |
| 3 | M | 57 | Sigmoid | Resection-anastomosis 10/1/43 | Combined 3/9/49 | ..... | ..... | Died 8/8/50 |
| 4 | M | 71 | Sigmoid | Resection-anastomosis 6/3/44 | Reresection 3/21/47 | ..... | ..... | Living 1/20/50 |
| 5 | M | 48 | Sigmoid | Resection-anastomosis 3/26/45 | Combined 1/21/46 | ..... | ..... | Died 11/17/46 |
| 6 | M | 61 | Sigmoid | Resection-anastomosis 9/12/45 | Combined 7/23/46 | ..... | ..... | Died 3/7/47 |
| 7 | M | 56 | Sigmoid | Resection-anastomosis 9/13/45 | Combined 2/10/47 | ..... | ..... | Died 6/3/47 |
| 8 | F | 54 | Sigmoid | Resection-anastomosis 4/25/47 | Reresection 8/25/48 | Reresection 11/16/48 | Combined and obstructive resection of hepatic flexure 5/27/49 | Died 12/4/49 |
| 9 | F | 53 | Sigmoid | Resection-anastomosis 12/2/47 | Reresection 10/5/48 | ..... | ..... | Died 3/3/50 |
| 10 | M | 52 | Sigmoid | Resection-anastomosis 7/13/39 | Reresection 10/16/40 | ..... | ..... | Died 5/17/41 |
| 11 | F | 54 | Sigmoid | Resection-anastomosis 8/4/49 | Combined 9/7/50 | ..... | ..... | Living 11/16/50 |
| 12 | F | 53 | Descending colon | Resection-anastomosis 10/28/49 | Reresection 2/22/50 | ..... | ..... | Living 8/2/50 (terminal) |

In 96 of the cases the operative procedure was only palliative. Eighty-seven (90.6%) of these patients have since died; 60% lived one year or less, and 92% two years or less. Seven patients lived from three to seven years. Patients who exhibited hepatic metastasis at the time of operation lived a somewhat shorter period than those with local irremovable extension only.

In the group of 352 patients who had operations for cure, 72% lived 3 years, 63% 5 years, 48% 10 years, and 38% 15 years.

With five-year survival as the criterion for assessment, no difference could be determined in the behavior of cancers of the right, the mid, and the left colon.

Metastasis to regional lymph nodes altered the prognosis unfavorably, the noxious effect becoming progressively greater from the second to the fifth year.

Invasion of pericolic adipose tissue by neoplasm likewise exerted an unfavorable effect upon five-year survival rates. This was slightly less marked than in the case of lymph-node involvement.

When neoplasms were classified according to the three commonly observed histological types—adenocarcinoma, papilliferous adenocarcinoma, and adenocarcinoma mucosum—relatively little difference in behavior was observed for the first two years. By the end of the fifth year the adenocarcinoma mucosum was found to have the lowest survival rate.

Patients with multiple nonsimultaneous primary carcinoma did unusually well. The findings emphasize the importance of careful check-up examinations of patients who have survived an initial resection. Should one or more new neoplasms be discovered, their removal may very well be associated with a clinical cure.

In cases of multiple simultaneous primary carcinomas, the results were poor.

Reresection for recurrence is occasionally feasible and worth while, but such operations are nearly always merely palliative in nature.

# POTASSIUM DEPLETION IN SURGICAL PATIENTS

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THE SURGICAL patient needs water and salt, calories and proteins, and he suffers if these needs are not fulfilled. Similarly he requires potassium, and serious manifestations may be expected when a depletion of potassium exists. The theoretical and clinical basis for potassium administration has been well established by other observers.[1] With the use of the flame photometer, potassium studies on surgical patients were begun in January of 1950. For the first four months routine daily potassium levels were obtained on practically all surgical patients. Profound deficits were encountered which were not rapidly corrected by our early attempts at treatment. Disturbing and serious manifestations of potassium deficits were observed, and certain causative factors were seen to be common to patients depleted of potassium. Confidence in the safety and effectiveness of potassium replacement grew rapidly. If a few simple rules of potassium therapy are followed, there should be few cases of severe potassium depletion.

## MATERIAL

Between January, 1950, and August, 1951, a total of 4,740 plasma potassium determinations were done in 1,358 hospitalized patients, and, in addition, many balanced studies were performed. The normal range of plasma potassium as determined in our laboratory was between 3.5 and 5.0 mEq. (14 to 19 mg. per 100 cc.). A total of 265 patients were below this normal range. Of this group, 180 patients were in the range of 3.0 to 3.5 mEq. (12 to 14 mg. per 100 cc.), and 85 fell below 3.0 mEq. (12 mg. per 100 cc.). No manifestations of potassium depletion of practical clinical importance occurred in the group of 180 patients whose plasma potassium fell to 3.0 to 3.5 mEq. In the group of 85 patients whose plasma potassium fell to below 3.0 mEq., 72 were surgical patients. In 27 the deficit was present on admission, and in 48 it occurred postoperatively.

From the Department of Surgery, Ohio State University, College of Medicine.

Read at the Fifty-Ninth Annual Meeting of the Western Surgical Association, Colorado Springs, Colo., Nov. 30, 1951.

1. (*a*) Govan, C. D., Jr., and Darrow, D. C.: The Use of Potassium Chloride in the Treatment of the Dehydration of Diarrhea in Infants, J. Pediat. **28**:541, 1946. (*b*) Randall, H. T.; Habif, D. J.; Lockwood, J. S., and Werner, D. C.: Potassium Deficiency in Surgical Patients, Surgery **26**:341, 1949.

RELATIVE FREQUENCY

On a service in which serious surgical problems are frequent, potassium deficits are relatively common and potassium balance must be considered as an integral part of electrolyte and fluid balance.[2] During the 20-month period of study reported, 2,600 patients were admitted, 27 of whom had severe potassium deficiency, roughly 1 out of 100 admissions. Postoperative potassium deficiencies are much more frequent. There were 38 postoperative deficiencies after 1,500 major operations or about 1 out of 30 (Fig. 1).

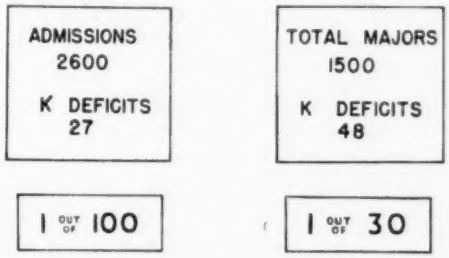



Fig. 1.—The frequency of potassium deficits on the surgical service over a 20-month period.

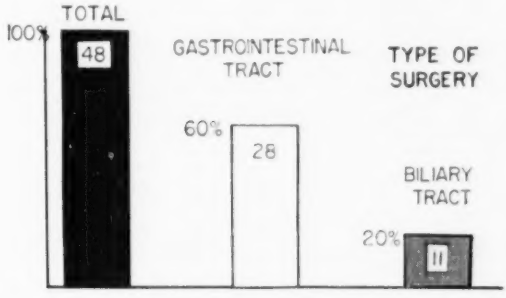



Fig. 2.—Postoperative potassium deficits frequently complicate surgery of the gastrointestinal and biliary tracts.

Postoperative potassium depletion occurs following the more serious and complicated abdominal surgery. In the 48 total cases showing severe postoperative deficits, the surgery involved the gastrointestinal tract in 28 cases and the biliary tract in 11 cases, and in many of the latter cases the procedures were secondary operations. This is shown in Figure 2. Morbidity and mortality figures were very high in these 48 patients. The morbidity in these cases was 28% and the postoperative mortality was 18%, while the over-all morbidity in the same period was 9% and the postoperative mortality was 2%.

2. Marks, L. J.: Potassium Deficiency in Surgical Patients, Ann. Surg. **132**:20, 1950. Cole, W. H.: Laboratory Aids in Surgery, with Special Reference to Potassium Deficiency, A. M. A. Arch. Surg. **62**:737 (June) 1951.

### MECHANISM

Potassium is lost from the body in the urine or through an abnormal gastrointestinal fluid loss. Both types of potassium loss plus a decreased intake are usually factors in each clinical case of potassium depletion. The abnormal gastrointestinal fluid loss may be by vomiting, suction, fistula, or diarrhea, and up to 90 mEq. of potassium (approximately 6 gm. of potassium chloride) per day has been seen to be lost from the body by these means.

Potassium is mobilized from the cell by dehydration, the "stress effect" of surgery, or an excess of salt administered parenterally, and is washed out in the urine by rehydration with potassium-free fluids. One hundred sixty milliequivalents of potassium (approximately 10 gm. of potassium chloride) has been measured in one 24-hour urine specimen. These amounts are greater than commonly seen, but average daily losses of 60 mEq. of potassium are not unusual in surgical patients who have intestinal suction and are on daily intravenous fluids.[1b]

Practically speaking, the patients admitted with a severe potassium deficit are starved and dehydrated and are vomiting. In the 27 patients showing deficits on admission, 9 out of 10 had a low intake and vomiting as the cause of their potassium depletion. Intestinal obstruction was the cause of vomiting in 68% of the patients. The inability to take food is important. There are only a few potassium-free foods, and any intake exclusive of water and tea supplies some potassium. For all practical purposes a normal diet precludes potassium depletion.

In the postoperative group the loss of gastrointestinal fluid is again the most important factor in the production of potassium depletion. The loss by vomiting and suction is by far the most common and the most important, and the actual loss may reach 90 mEq. of potassium per day (approximately 6 gm. of potassium chloride). Long-tube suction is more important than gastric suction because of the greater amount of fluid removed.

In this total series of 72 surgical patients in whom the plasma potassium fell below 3 mEq. (12 mg. per 100 cc.), 9 out of 10 patients had a loss of gastrointestinal fluid by vomiting or suction and a decreased intake as the major causative factors in their potassium deficit. In almost half of the patients the use of potassium-free fluid in rehydration was also important.

### DIAGNOSIS

Signs and symptoms of potassium deficiency usually appear when the plasma potassium falls below 3.0 mEq. (12 mg. per 100 cc.). They are bowel distention, weakness, irritability, drowsiness, and aphonia. Of these the commonest manifestations are weakness, which occurred in 7 out of 10, and distention, which occurred in 5 out of 10 cases. Electrocardiographic changes are usually produced by a marked potassium deficiency, and these changes revert to normal as the plasma potassium rises to normal. The electrocardiographic findings are lowered T waves, a depressed S-T segment, and a prolonged Q-T interval.[3] These findings are seen only when the plasma potassium falls to seriously low levels, and in many cases are not significant unless they can be compared to a tracing on the same patient in a normal state.

3. Martin, H. E., and Wertman, M.: Electrolyte Changes and the Electrocardiogram in Diabetic Acidosis, Am. Heart J. **34**:646, 1947.

The laboratory findings of a hypochloremic alkalosis indicate a potassium deficiency.[4] As a clinical rule, this state can be corrected only when potassium is administered. However, hypochloremic alkalosis is relatively infrequent; it appeared in only 1 out of 10 cases of hypopotassemia. Hypochloremia without alkalosis is more common, and was seen in one out of five.

The diagnosis is made by finding a lowered plasma potassium. None of these diagnostic methods are recommended as the final answer to the need for potassium therapy. Potassium depletion should be forestalled by administration before a severe deficit exists.

### INDICATIONS FOR THERAPY

Primarily, a potassium depletion should be anticipated and prevented. The prophylactic administration of potassium is indicated (1) after rehydration of a severely dehydrated patient, (2) when gastrointestinal fluid loss is prolonged over

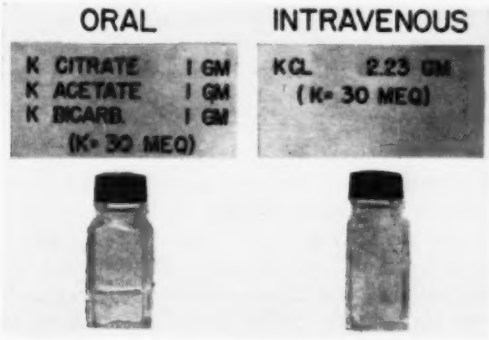



Fig. 3.—The potassium preparations in containers ready for use, as originally described by Lockwood, Randall, and others.[1b]

48 hours, (3) when parenteral fluid therapy is continued for 48 hours and diet is restricted, and (4) in those patients having major abdominal surgery.

Active treatment is of course started (1) when there are clinical manifestations of potassium depletion in a situation predisposing to hypopotassemia, and (2) when the plasma potassium is below normal.

### PREPARATIONS

Commerical preparations of potassium are available, both in concentrated solution to be added to intravenous mixtures and a 0.4% solution of potassium chloride for intravenous use. The preparations originally described by Lockwood and Randall[1b] are preferred because of their low cost, simplicity, and safety (Fig. 3).

Oral administration is the safest and most effective means of giving potassium. An oral mixture put up in single-dose bottles is simple and well tolerated. It is made up by using 1 gm. each of potassium citrate, potassium acetate, and potassium bicarbonate dissolved in 8 cc. of water. Although most patients take the preparation

4. Evans, E. I.: Potassium Deficiency in Surgical Patients: Its Recognition and Management, Ann. Surg. **131**:945, 1950.

without complaint, the taste can be disguised by addition to orange juice or any flavored beverage. When the oral route is not available, intravenous administration is used. Individual doses weighed out, stored in small sterile bottles, and designed for addition to 1 liter of intravenous solution have been used. The sterile bottle contains 2.23 gm. of potassium chloride, which is equivalent to 30 mEq. of potassium. This in most instances represents an adequate daily dose which can be safely administered when added to 1 liter of fluid.

### DOSAGE AND METHODS OF ADMINISTRATION

The oral route should be used whenever possible. Nine to 12 gm. of potassium preparation divided into three doses is usually adequate. As much as 20 gm. is given when required.

If potassium is given intravenously, 2.23 gm. of potassium chloride is added to the second liter of fluid. If intestinal intubation has been instituted with long tube suction, potassium loss is increased, and two to three intravenous units (4 to 6 gm. of potassium chloride) are given daily. In no case is more than 30 mEq. of potassium (2.23 gm. of potassium chloride) added to 1 liter of intravenous fluid unless repeated and frequent plasma potassium determinations can be obtained to avoid toxic plasma potassium levels.

### RESULTS OF TREATMENT

In our total of 72 patients who showed a marked potassium deficit, 27 had such a deficit on admission to the hospital. Proper treatment of these patients produced a rapid response in the majority of cases. Twenty-one, or 80%, of these patients responded rapidly, and six, or 20%, responded slowly or not at all. Of this last group two had terminal malignant disease and four appeared early in the course of our study and were inadequately treated. Of the 21 patients showing the good response, one was treated by the oral route and received 90 mEq. of potassium per day (6 gm. of potassium chloride). Twenty were started on intravenous therapy and received 30 to 90 mEq. of potassium per day (2 to 6 gm. of potassium chloride). Intravenous treatment was never started until dehydration had been corrected and a good urine output was present.

Potassium depletion on admission when properly treated did not increase the risk for subsequent surgery. There were 19 patients admitted with potassium deficits and later operated upon. One of these patients had a terminal malignancy and cannot be considered. Two patients had insufficient treatment prior to operation; one of these patients died and the other had a long postoperative course marked by persistent low plasma potassium. Sixteen of the nineteen total we considered to be well managed. Thirteen of these patients were operated on with good results. They presented no electrolyte problem and only one complication. Of the three unimproved, in only one was an electrolyte imbalance a problem.

The largest group of patients showing potassium deficiency was the postoperative group. In 48 patients potassium deficits were seen to develop during their postoperative period. In 6 of 10 cases the diagnosis of potassium deficiency was made during the first four days, and 90% of our postoperative deficits occurred in the first postoperative week (Fig. 4).

In the review of a total of 48 postoperative cases, 6 were terminal cases and the potassium deficit occurred just before death. Of the others, 29 were well managed and in 13 treatment was insufficient. In the well-managed group of 29 cases, 26 showed a rapid response to the administration of potassium and no ill effects from potassium deficits. Three patients died, but serious and inoperable surgical disease, and not electrolyte imbalance, was responsible for their death. In 13 cases treatment was considered to have been insufficient. In these cases the patients were admitted during the first few months of study and many had clinical manifestations which at the time were not recognized as evidence of potassium depletion. All of them had a prolonged postoperative course marked by abdominal distention, weakness, and extreme difficulty in controlling electrolyte balance. Four showed a prompt response when potassium was given late in their postoperative course; three responded more slowly to inadequate potassium administration. Four responded only when a full liquid diet was started despite distention and tube suction, and two of these patients had blood transfusions. These early cases show better than any others the real

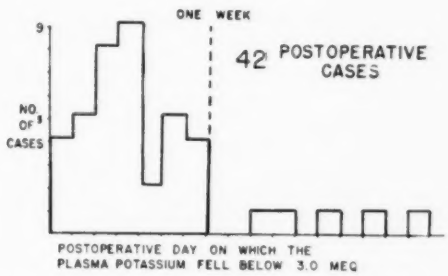



Fig. 4.—In 90% of the cases, potassium deficits occurred in the first postoperative week.

problems that accompany potassium deficiency in surgical cases and the gratifying response of depleted patients to potassium administration. From these early cases the rules of management which were applied to later cases were formulated. The response to potassium administration in a patient who has a potassium deficit is prompt and persistent. It is not necessary to correct completely the deficiency before a response is obtained. In the average case, active treatment is started intravenously with a change to the oral route as soon as feasible.

## CONTRAINDICATIONS

When potassium is given, the urine output must be satisfactory, and assurance must be given that severe kidney damage is not present. The dehydrated patient will have a normal or frequently an elevated plasma potassium which will drop below normal in 8 to 12 hours with rehydration. When fluid is given to dehydrated patients, potassium is never added to the first or second liter.[5] After a good urinary output is ascertained, potassium administration is safe.

5. Ellison, E. H.; Morgan, T. W., and Zollinger, R. M.: Practical Aspects of Potassium Therapy in the Surgical Patient, Ohio M. J. **47**:839, 1951.

## CONCLUSIONS

1. Potassium deficits are commonly encountered in surgical patients.

2. These deficits result chiefly from loss of gastrointestinal fluid.

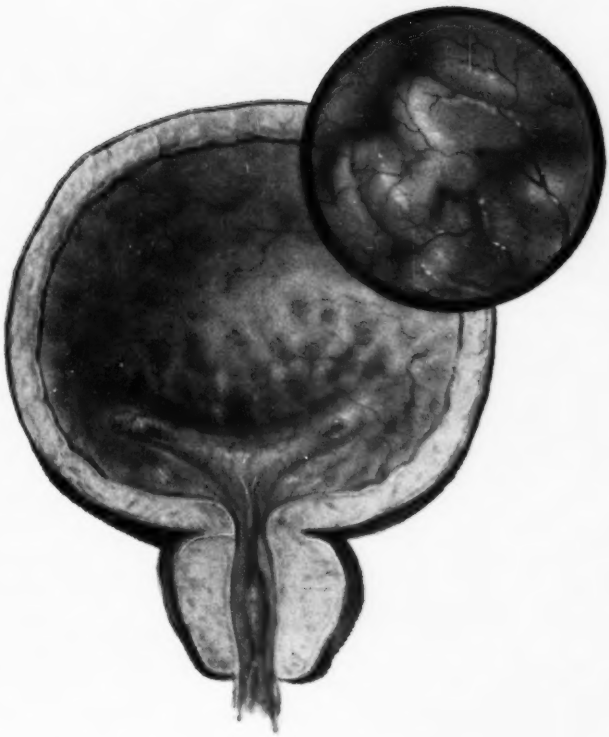
3. The depleted patient has clinical manifestations which are rapidly improved with potassium administration.

4. Severe potassium depletion may be prevented by an awareness of the causative factors.

5. Safe, effective, and economical potassium preparations are readily available.

## DISCUSSION

DR. RICHARD PATTON, Columbus, Ohio: There is one further point. This study was undertaken to determine whether safe and simple rules for potassium administration could be formulated. Although difficult cases will always require repeated laboratory investigations, in many instances potassium therapy can be utilized, if these rules are followed, even when serum potassium determinations are not available.



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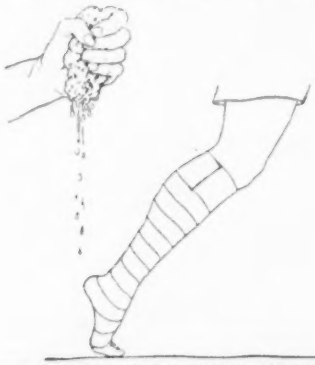

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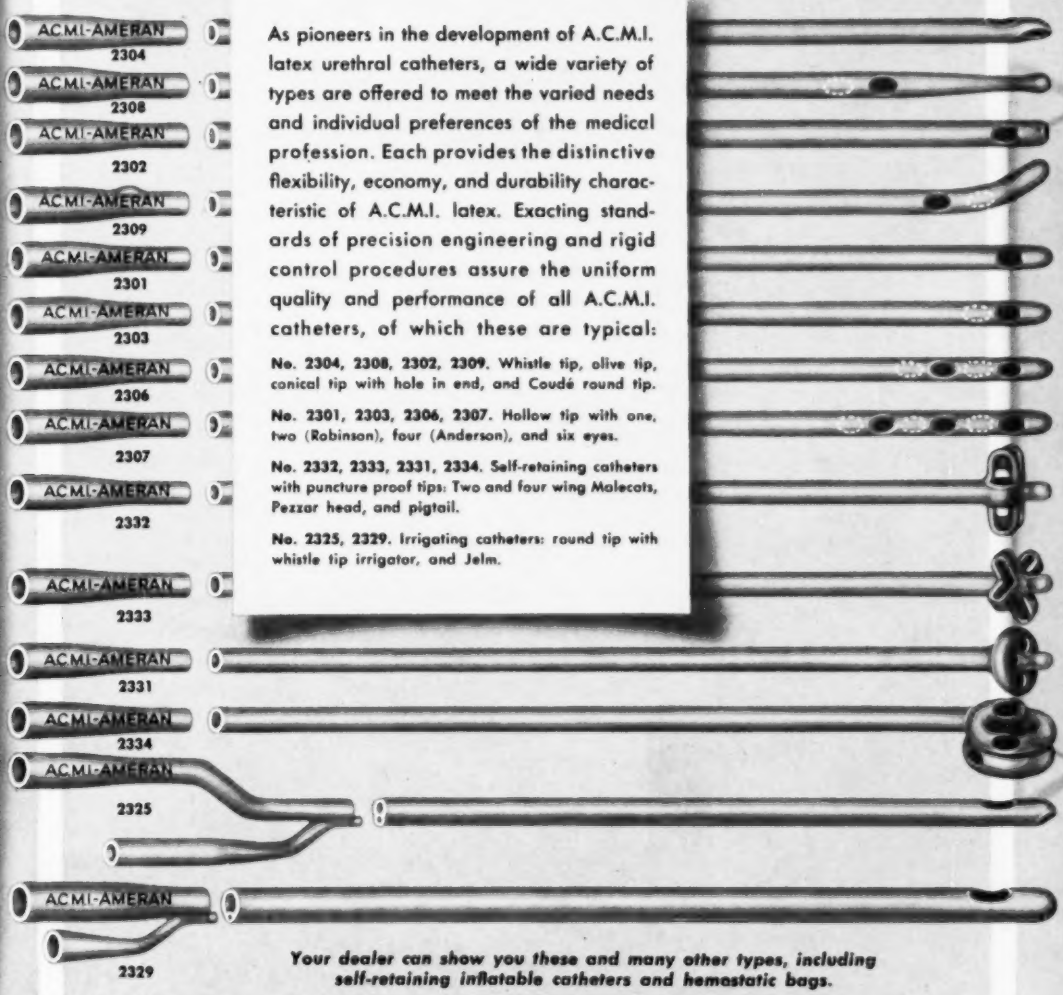


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